Virtual Supplier Diversity: The Business-to-Business implications of low-tech Entrepreneurial Ethnic Minority Businesses in a virtual environment

Dr Martin John James Beckinsale,
Darshan Pancholi and
Mayank Shah

Contact: Dr. Martin J. J. Beckinsale
Title: Senior Lecturer in Strategic Management
University: Leicester Business School, De Montfort University
Phone: 0116 257 8231
Email: mbeckinsale@dmu.ac.uk
Abstract
The evidence of limited ICT adoption and use among Ethnic Minority Businesses is growing, supported by the work of Ram and Smallbone (1999), Foley and Ram (2002) and SBS (2004). The reasons discussed are many including firm size, lack of skills, culture, markets and sectors (SBS, 2004 and Allinson et al, 2004). However, existing examinations of ICT adoption and use by EMBs have failed to consider business-to-business (B2B) activities especially by firms in sectors where B2B activities are rapidly developing and increasingly the norm. Given, the increasing economic impact of EMBs in the UK and the growing push towards international trade the paper identifies the factors that both aid and limit B2B development among EMBs and potential International partners. The focus of B2B development is the UK’s first Virtual Trade Fair bringing UK EMBs, US EMBs and US Corporates together virtually. The paper identifies a number of factors creating and limiting B2B development and the formation of any international strategic alliances including: limited ICT use; limited understanding and use of virtual trade fair technologies, operating sectors and markets. The recommendations to overcome such issues include greater inclusion of EMBs in UK government backed e-procurement programmes, improved matching of sectors between buyers and sellers and raised ICT awareness and adoption in the EMB community.

Introduction
Until a few years ago, research examining the relationship between Ethnic Minority Businesses (EMBs), Information Communication Technologies (ICT) and Business-to-Business (B2B) activities was very rare. The first study to consider any issues surrounding ICT and related technological adoption was signalled by Ram and Smallbone (1999) with later research undertaken by Foley and Ram (2002) and more recent Small Business Service (2004) data identified a lower ICT adoption rate than in the non-EMB population.

The ICT literature offers many reasons why adoption may be more difficult for small and especially micro-businesses given their shortage of resources (Premkumar & Roberts, 1999) and lack of capacity to view ICT strategically (Levy et al, 2001). However, in relation to EMBs, Owen et al (2000) underscore the impact of the changing demographic profile and entrepreneurial potential of ethnic minority groups on the future economic development. Given that their growth potential is closely related to their ability to breakout of traditional sectors of low value added activity (Ram and Jones, 1998), diversification and market development through exporting and international trade are activities which are highly favourable. Such developments require and support increasing technological use and therefore ICT. This is most pertinent given the drive by leading US corporations who are expanding their supplier diversity strategies globally. Although the possible explanations for the discrepancy are not as conclusive, the emphasis, at least in policy circles, is turning to measures to improve the uptake of ICT and use of ICT in B2B processes.

The paper therefore focuses on entrepreneurial EMB owners that have diversified and are, if not already, trading outside the UK. Qualitative and quantitative data was gathered from the thirty-six UK EMBs as well as US EMBs involved in a United Kingdom Trade and Investment (UKTI) funded project. The objective was to foster Ethnic Minority Business (EMB) development through transatlantic strategic alliances utilising virtual technology namely a Virtual Trade Fair (VTF). All the EMBs are SMEs, have low ICT use and low technological adoption. The Virtual Trade Fair 2005 was the first to be held officially in the UK.
The paper examines and provides details on the activities, issues, benefits and learning outcomes derived from UK EMBs engaging in a particular electronic ‘functional hub’ (Ho et al., 2002) namely a Virtual Trade Fair. Furthermore the findings provide recommendations and policy implications focused around the following themes: EMB ICT adoption; the development of international supplier relationships through a virtual environment; developing hi-tech ICT awareness provision such as e-procurement.

**Ethnic Minority Businesses & International Trade**

The role of EMBs has been amplified throughout industrial societies. Owen et al (2000) highlight the growing importance of the ethnic presence in Britain and the value in relation to future economic development. EMBs constitute almost 10 per cent of the UK small business stock, while certain areas exhibit much higher proportions. In addition, the purchasing power of ethnic minority groups is markedly increasing. Undeniably, this has significant socio-economic implications for the UK as a whole and for the regions exhibiting a strong ethnic presence.

It is noteworthy that EMBs, beyond fulfilling a significant economic and social role for the minority communities themselves, have contributed to the revival of the small-firm stock, the transformation of particular economic sectors and the regeneration of depressed inner-city areas (Ram and Barrett, 2000), and by implication they certainly contribute to the achievement of macro-economic and social objectives at a broad level (Deakins and Freel, 2003).

Broadly, international trade is vital to the UK economy, as it enhances competitiveness, growth and prosperity. Success in overseas markets helps the UK economy expand and ameliorates the balance of payments. As EMBs constitute an integral and undoubtedly dynamic element of the British economy, improving their ability to engage in exporting would appear to be worthwhile. Given that their growth potential is closely related to their ability to breakout of traditional sectors of low value added activity (Ram and Jones, 1998), diversification and market development through exporting and international trade are activities highly favorable from a business support provision and policy making perspective.

**EMBs and Information Communication Technology**

Exporting and International Trade is increasingly utilising and standardising Information Communication Technologies (ICT). Limited but increasing research into Ethnic Minority Businesses (EMBs) and their adoption and use of ICT suggests that exporting and international trade from a B2B perspective is likely to be very limited. The adoption of ICT includes the use and purchase of computer hardware, software, data and communications technology. For the purposes of this paper ICT, is defined as ‘any technology used to support information gathering, processing, distribution and use’ (Beynon-Davies, 2004: 7-8). Ram and Smallbone (1999) found 15% of a sample of some 1800 firms comprised EMBs were significantly less likely to be users of ICT than white owned firms. Only 64% of EMBs used ICT for some purpose compared with 89% of white owned firms. Moreover, the lower level of computer use by EMBs could not be explained by their smaller average size. For example, 82% of white owned micro enterprises were using computers for some purpose compared with just 54% of EMBs in this size group (Ram and Smallbone 1999:16).

Foley and Ram’s (2002) findings identified a lower adoption rate than in the non-EMB population. The adoption level differed significantly with only 37% of micro EMBs having Internet access compared to 75% of micro non-EMBs. Further, findings showed significantly
lower rates for business website development and the use of online technologies to transform business operations such as invoicing, online ordering and payment. The Small Business Service (SBS) survey (2004) noted a smaller disparity with 65.8% of micro EMBs now using ICT. Hence, the gap between ICT take-up in non-EMBs and EMBs would appear to be closing; but this apparent change must be viewed with some caution. ICT use by EMBs tended to be orientated to lower level functions i.e. PC use for word processing or accounts and email. A significant finding of the SBS (2004) survey was the differences between ethnic minority groups. African-Caribbean businesses adoption rates were comparable to their non-EMB counterparts; but Chinese business owners, at 32.9%, were the least likely to use ICT. Pakistanis and Bangladeshis EMBs had a higher rate of use at 57%. In relation to website adoption EMBs were in low single figures (Chinese – 3.4%, Pakistani – 3.5% and Bangladeshi – 5.4%) compared to over 22% of non-EMBs.

The possible explanations for the disparity appear to include size, sector and generation of business owner. Although the absence of comprehensive, large-scale business databases that include an ethnic variable makes it impossible to paint a totally accurate picture, it is widely accepted that most EMBs are not just small, but very small firms (Ram and Smallbone, 2002). Hence they are likely to suffer from a lack of capacity to view ICT strategically (Levy et al, 2001) and limited resources (Premkumar and Roberts, 1999). However, Ram and Smallbone (1999) note that firm size is in itself unlikely to explain the discrepancy. The possibility of the disparity being sector related was highlighted by Allinson et al (2004) who noted a tendency for EMBs to cluster in particular sectors and advanced this as an explanatory factor on the basis of their evidence collected from focus groups with EMBs. Allinson et al (2004) also suggest that second generation business owners are more likely to be receptive to ICT than their first generation counterparts; recent surveys of EMBs support this observation (CEEDR, 2001; Ram et al, 2003).

Although the ICT gap is closing, it is clear that EMBs continue to be less likely to utilise ICT than their non-EMB counterparts. Evidence is also extremely limited regarding the use of ICT in B2B activities among EMBs. The rates of B2B activity highlighted in the SBS (2004) survey go even further to suggest such activity, is limited if not rare. Although it should be noted that rates of B2B activity in non-EMB businesses is only very slightly higher with 4% of EMBs procuring electronically compared to 6.6% of non-EMBs (SBS, 2004: 2).

**Business-to-Business and The Virtual Trade Fair**

It has been argued that business-to-business (B2B) ecommerce is even more critical to economies than business-to-consumer (B2C) ecommerce (Cunningham, 2002). Along with figures suggesting that B2B commerce is potentially ten times the value of B2C (Beynon-Davies, 2004: 325) then ICT innovations in this area have great potential for businesses. B2B activity is well defined with Cunningham (2002) providing a clear ICT related definition that highlights the use of public or private networks, including public and private transactions that use the Internet as a delivery vehicle for business transactions. Transactions may include financial transfers, on-line exchanges, auctions, delivery of products and services, supply-chain activities and integrated business networks (Cunningham, 2002). It is the supply chain development that is viewed as critical to this paper in the B2B context.

The literature (Beynon-Davies, 2004; Chaffey, 2003 among others) identifies a number of distinct models relating to suppliers, buyers, intermediaries or partnerships each is summarized in table 1. Each model requires supply chain activities to be developed through varying ICT based technologies.
Table 1: Summary of B2B Models (adapted from Beynon-Davies, 2004: 330)

<table>
<thead>
<tr>
<th>B2B Model</th>
<th>Characteristics</th>
</tr>
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<tbody>
<tr>
<td>Supplier-orientated</td>
<td>Involves one supplier and many potential buyers</td>
</tr>
<tr>
<td></td>
<td>Often involves use of e-shop or online catalogue</td>
</tr>
<tr>
<td>Buyer-orientated</td>
<td>Involves one buyer and many potential suppliers</td>
</tr>
<tr>
<td></td>
<td>Often involves e-tendering, bidding and e-procurement</td>
</tr>
<tr>
<td>Intermediary-orientated</td>
<td>Involves many suppliers and many buyers</td>
</tr>
<tr>
<td></td>
<td>e-marketplaces are a common element in the process</td>
</tr>
<tr>
<td>Partnership-orientated</td>
<td>Involves one buyer and one supplier</td>
</tr>
<tr>
<td></td>
<td>A relationship that develops through integration of information systems most using Extranets</td>
</tr>
</tbody>
</table>

The benefits of such activities are well documented (Chaffey, 2003; Turban, 2004 and Willcocks et al 2000) and include lowering purchasing costs, reducing inventory, lowering cycle times (time to market), efficiency improvements (resource savings and efficacy improvements e.g. better information and relationships) As stated by Ho et al (2002: 425) ‘The advancement and deployment of information technology (IT), in particular the Internet and Web-based technology, has transformed conventional way of conducting business.’

New business models in digital markets include auctions, aggregators, bid systems, and exchanges (Ho et al, 2002). Forrester Research estimated that by 2004, digital markets will capture 53% of all online business trade and by 2006/7 will account for €2.2 Trillions worth of business transactions across Europe. Fostering such trade has resulted in the development of ‘functional hubs’ (Dou and Chou, 2002) that support the identified business models and make full use of the potential of ICT. The focus of this paper in one particular functional hub ‘The Virtual Trade Fair’. The VTF is well developed in the United States as an Intermediary-orientated business-to-business model. Rounds (2002:1) provides one definition ‘An entire convention centre full of people, products, and informational materials made available to participants via their computers and the web.’ However, this definition is based on a very traditional view of trade shows. It does not capture the ‘virtualness’ of the experience, the need for potentially high levels of information to be transacted or the fact that attendees are from targeted groups. Further, it fails to appreciate that the virtual environment offers many more ways to communicate and interact live than in the traditional trade show environment. The ability to communicate will be fostered by the availability of advanced technologies such as audio messaging and video conferencing, rather than the tried and tested Information Communication Technology (ICT) activities such as email, chat forums and electronic business cards.

Virtual Trade Fairs have not been developed to remove the need for traditional trade shows. US research relating to VTFs highlights the case that not all attendees are comfortable or wish to do business exclusively through a virtual environment. ‘Many people still like to travel, mingle with other real people who have the same needs and interests, play touchy-feely with the products, and speak face to face with the vendors.’ Rounds (2002: 2)

However, the advantages are well documented including: no need to travel, no need to leave office or desk, potentially more focused activity by both exhibitors and attendees, can support business relationship development through B2B intermediaries, flexibility in terms of show length, cheaper than conventional trade shows. These advantages offer varying degrees of tangible benefits. Lower costs are certainly a tangible outcome however there is no guarantee that business relationships will develop. It is clear that whether in a virtual or non-virtual
The environment developing trade through a show, at the very least, requires communication, understanding and knowledge and a product or service the attending buyers wish to negotiate over.

**Research Methodology**

In line with UK Trade & Investment's objective to foster Ethnic Minority Business (EMB) development through transatlantic strategic alliances, the Virtual Trade Fair (VTF) project aimed to facilitate this activity through the use of virtual technologies. The VTF provided a substantial virtual floor space to thirty-six growth-oriented ethnic minority businesses in an exclusive UK pavilion at the 5th Supplier Diversity Virtual Trade Show held in 2005.

With approximately 5% of the total population of 4.15 million in the East Midlands being from an ethnic minority group and this figure being the third highest for any region in England unsurprisingly a relatively high proportion of the thirty-six EMBs were from the East Midlands region of the United Kingdom (see Table 2). There were also EMBs based in the West Midlands, Bradford and London.

<table>
<thead>
<tr>
<th>Region</th>
<th>% of participant UK EMB</th>
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<tbody>
<tr>
<td>East Midlands</td>
<td>62%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>15%</td>
</tr>
<tr>
<td>South East</td>
<td>20%</td>
</tr>
<tr>
<td>South West</td>
<td>3%</td>
</tr>
</tbody>
</table>

A number of reasons led to this feature of the study. The thirty-six EMBs represented twenty-two business sectors/markets ranging from Financial, Information Technology and Management Consultancy to Food and Catering, Waste Management and Packaging. EMBs in the Information Technology sector represented 11% of all the businesses, with design and printing, consultancy and recruitment a close second, third and fourth. Marketing & Media, Recruitment and Software Management made up a significant proportion of the rest at 20% of the total. In terms of firm size the thirty-six EMBs fall into the following categories: 58% were micro firms (0-9 employees); 33% were small firms (10-49 employees); and 9% were medium small firms (50-249 employees).

Data gathering utilised both quantitative and qualitative methods. Such a ‘multi-method' approach is particularly helpful in understanding how policies achieve their effects (Sanderson, 2002) and how the VTF fosters business relationships. Three data gathering exercises were used and included: feedback, questionnaires and online interviews. These approaches focused on initial involvement and expectations, the 30 days of the Virtual Trade Fair including activities, issues and initial engagement and a reflection on the activity and the outcomes resulting from involvement.

All thirty-six businesses from the UK were asked to complete a feedback form (questionnaire) related to Virtual Trade Fair. This data was primarily quantitative and informs from both sides of the Atlantic, their feelings, attitudes and opinions about the experience and outcomes. Potentially quantitative data gathering responses can be low (Saunders et al., 2002) including formal feedback responses. Therefore, a further questionnaire was provided to all UK based EMBs that set-up a booth. This was for two reasons: first to reduce potential problems regarding the response rate and secondly and more importantly to gather further quantifiable data. Data included: previous virtual business activities; use of the virtual trade
fair; how leads where developed; opportunities identified; and details regarding the type of relationship that was developing (customer – supplier – B2B).

Qualitative data was also gathered from the thirty-six UK EMBs, as well as, US EMBs and US Corporate Buyers who were approached online through the live chat forum and interviewed online. This was important given the need to understand the relationships developed but also to identify issues that limited the US EMBs developing relationships with UK EMBs through the virtual environment. The qualitative data gathering utilised semi-structured interviews conducted within the live chat room. Therefore the technology itself was utilised to undertake the research and gather data.

**ICT Use By Ethnic Minority Businesses (EMBs)**
Given the low-level adoption and use of ICT by UK EMB businesses (Ram *et al.*, 2003; SBS, 2004) we would expect the same to be true of those exhibiting at the VTF. The following findings and discussion revolves around the ICT activities of these EMBs and considers its impact on virtual trade show involvement and use.

Of those using email over 80% engage through this technology with both customers and suppliers. This suggests an ability to communicate with key stakeholders through electronic means. The responses from the EMBs provide a number of reasons for why they adopted email within their business processes. The reasons focused on costs and business process benefits. 78% used email and limited IT/IS to reduce costs and also viewed the technology as a better way to collaborate with suppliers. All 100% viewed IT generally as vital to business process efficiencies.

The low level Intranet use (see Table 3) also supports a lack of integration of Information Technology (IT) and Information systems (IS). This was not surprising given 91% of UK EMBs were small or micro firms (Levy and Powell, 2003) supporting Ram *et al’s* (2003) findings regarding low level ICT adoption by UK EMBs especially in relation to integrated IT and IS operations. However, remarkable use of IT as a communication tool rather than a business process tool showed progress from Ram *et al* (2003) findings.

Significantly the low ICT use is evident for e-commerce and e-procurement. This is potentially significant given the potential for greater e-commerce activity through the medium of the VTF. Only 7% of businesses had ever engaged in e-commerce and 14% in e-procurement activities. However, B2B invoicing (with suppliers) was utilised by 57.1% of EMBs. The low e-procurement figure suggests that the much higher electronic invoicing figure was based on email invoicing and is not part of an integrated e-procurement system.

<table>
<thead>
<tr>
<th>ICT Use</th>
<th>% of UK EMBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>93%</td>
</tr>
<tr>
<td>Internet</td>
<td>93%</td>
</tr>
<tr>
<td>Intranet</td>
<td>21.4%</td>
</tr>
<tr>
<td>e-Commerce enabled</td>
<td>7%</td>
</tr>
<tr>
<td>Engage in e-procurement</td>
<td>14%</td>
</tr>
<tr>
<td>Electronic Invoicing</td>
<td>57.1%</td>
</tr>
</tbody>
</table>

Businesses were also asked about exposure and prior use of other ICT tools. Exposure included audio, video conferencing and message/bulletin boards. These were examined given their significance regarding interaction within the VTF. Not one of the UK EMBs had
previous exposure or experience with the use of audio/video conferencing or message/bulletin boards. Therefore, low uptake of more innovative ICT offerings during the VTF was evidenced generally, with an exception of high usage by EMBs in IT sector.

The benchmarked data raises a number of themes and issues. Firstly the largest population of businesses were represented by sectors predominantly in the areas of IT, Media, Marketing and EMBs offering consultancy services. This factor begins to explain the higher use of email and the Internet, by UK EMBs, for business purposes relative to the national perspective. These sectors are high users of ICT compared to almost any other (Levy and Powell, 2003). However, the use of higher-level innovative ICT tools was very limited and where used it was primarily among IT sector EMBs.

**Drivers For Engagement**
Exhibiting EMBs were asked about prior involvement in trade shows implicitly avoiding involvement in Virtual Trade Fairs as this EMB virtual trade fair is the first outside of the United States. Over 70% of UK EMBs had been involved in traditional trade shows/fairs previously with 70% of them making use of them to market products and services. Therefore, over 70% were pre-disposed to the possibility of a virtual trade fair.

**Table 4: Drivers for Participation**

<table>
<thead>
<tr>
<th>Drivers for Participation</th>
<th>% of UK EMBs</th>
<th>Drivers for Participation</th>
<th>% of UK EMBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify new Customers</td>
<td>7%</td>
<td>To communicate with potential suppliers and customers</td>
<td>42.90%</td>
</tr>
<tr>
<td>To purchase from others</td>
<td>7.10%</td>
<td>Research new markets</td>
<td>50%</td>
</tr>
<tr>
<td>To solve business problems</td>
<td>7.10%</td>
<td>No need to travel</td>
<td>57.10%</td>
</tr>
<tr>
<td>Identify new Suppliers</td>
<td>14.30%</td>
<td>No time away from the office</td>
<td>57.10%</td>
</tr>
<tr>
<td>Subsidised rates</td>
<td>22%</td>
<td>Examine potential of VTF</td>
<td>93%</td>
</tr>
<tr>
<td>To engage with other EMBs</td>
<td>28.60%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The initial data on the drivers to participate provided a low response to communicating with potential customers and/or suppliers. However, the Virtual Trade Fair was viewed by 93% of the UK EMBs as an opportunity to examine the potential of such B2B virtual environments (see Table 4). The opportunity to explore/research new markets was viewed as important by 50% of the businesses. The reasons given by EMBs for taking part start to offer a picture of goals that some of them may have during their engagement within the VTF.

**Table 5: Set Goals For Attending**

<table>
<thead>
<tr>
<th>Summary of Set Goals For Attending VTF for exhibiting EMBs</th>
<th>% of UK EMBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>To obtain at least one customer lead</td>
<td>78.6%</td>
</tr>
<tr>
<td>To try out the technology for the future</td>
<td>14.3%</td>
</tr>
<tr>
<td>To engage with US based businesses</td>
<td>21.4%</td>
</tr>
</tbody>
</table>

When EMBs were asked to consider their objectives or goals for attending the picture begins to change (see Table 5). Important was the high response to obtaining at least one customer lead. All aimed to generate new business whilst networking with existing suppliers was only an objective of 40% of those that had previously attended a trade show/fair. However, just under 20% actually set a goal to engage with US based businesses. These views present a somewhat contradictory picture with regards to drivers to participation, though 78.6% of UK EMBs intended to generate at least one customer lead only 7% were prepared to identify new
customers. This may be due lack of experience in exhibiting in VTF and exposure to e-business.

Involvement in the virtual trade fair was mainly driven by exploratory interest to try something very new and utilise the opportunity to test the new innovative technology. Although the main driver to engage was not to develop business relationships, it was evident that when they considered possible objectives related to their involvement that obtaining a customer lead was a prime aim.

Setting Up The Virtual Environment: The EMB Perspective

The VTF is a novel business development platform that almost no EMBs had exposure to across the UK. The relatively limited awareness and knowledge of ICT meant that support was likely to be required to assist EMBs in deploying an online booth. All UK EMBs were offered onsite and online support to set-up their virtual booths in advance. However with almost 60% of the UK EMBs being micro business the IT support officer of the VTF struggled to get their appointments and hence some exhibiting EMBs struggled to set-up their booths on the inaugural day of the VTF. Though eventually all booths were setup for the three day exhibition.

Booths were placed in particular participant categories chosen on the basis of the business sectors agreed and identified before the VTF. Discussions between the VTF team and the UK EMBs developed specific categories appropriate to all in the same sector or appropriate to a particular set of businesses with in a sector. Hence, a US buyer entering the UK Hall and then entering the Graphic Design participant category would have only found one UK EMB; the others, from a similar business sector, were found in the Marketing and Communication participant category. The US Virtual Trade Hall adopted an identical approach to participant categories. It should be noted that the US Virtual Trade Hall had a larger number of participants across a wider set of participant categories.

All the booths in the UK Hall of the VTF had the same tools available for use (i.e. bulletin board, drop a card, pickup a card, website, e-mail, chat, corporate description, press release, literature, video, presentations) at their discretion. Given the data regarding current ICT use and the limited knowledge of VTFs the UK EMBs were most comfortable with the use of email and digital business cards.

The evidence from the first VTF in the UK highlights the requirement for training and support to setup the booths for EMB exhibitors. It should be noted that even though it is fairly simple to setup a booth as it is all automated, business owners have limited time and in many cases know-how which have always been a major reasons for a lack of adoption of ICT (Poon and Swatman, 2000; Levy et al, 2001)

Technology Used During The VTF

The objectives of the technologies used were all centered on initiating business relationships. Broad ranges of technologies were available to initiate the communication process from email, live chat forum, bulletin boards. Email was viewed as the most useful by almost 60% of UK EMBs.

The live chat forums were used sparingly in the initiation of a business relationship. There was marginal uptake of live chat forums by UK EMBs as a business communication tool. It should be noted that during the first few days of the virtual trade fair 30% of UK EMBs had
difficulties in using the live chat forums and the online windows would disconnect during discussions. Many businesses therefore chose not to continue using them during the live event. UK EMBs did use electronic business cards frequently and with positive results. When used they were predominantly utilised due to requests from US EMBs and led to UK EMBs asking US EMBs to make use of the phone. Such activity leads to greater communication expense negating the cost savings of online transatlantic communication.

Audio messages and video conferencing were not used to initiate relationships or foster its continued development. With none of the UK EMBs having used such technologies before and a lack of knowledge or training to use them in virtual environments means this is unsurprising.

<table>
<thead>
<tr>
<th>Business Communication amongst Exhibitors and visitors at VTF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicators</td>
</tr>
<tr>
<td>UK Participant EMBs</td>
</tr>
<tr>
<td>Participant Category Communication</td>
</tr>
<tr>
<td>Number of Cards Exchanged by UK Participant EMBs</td>
</tr>
<tr>
<td>Number of Cards Dropped by US EMBs with UK EMBs</td>
</tr>
<tr>
<td>Total Virtual Business Card transaction between UK EMBs and US EMBs/Corporate Visitors</td>
</tr>
</tbody>
</table>

Table 6 summarises the virtual business communications that occurred amongst the exhibitors. In total the thirty-six UK EMBs engaged in 733 electronic business card transactions with exhibitors and visitors (suppliers-buyers-EMB 2 EMB). Of those 733 electronic business card transactions UK EMBs initiated 140. The UK EMB exhibitors actually received 156 electronic business cards from US exhibitors. Between UK EMBs communications were low with only 65 communications made between UK EMBs. Hence, almost 2.5 times as many communications were made between US EMBs and UK EMBs than between UK EMBs. The highest exchange rate, related to a UK EMB in the recruitment sector who received and responded to 10 electronic business cards during the active 3 days of the virtual trade show. The following quotes provide just a few of the examples given by UK EMBs of US EMB communication:

UK EMB: ‘I sent a card to Kodak and the Diversity manager has sent a mail to his counterpart in the UK… I have got a few companies from UK and US dropping business card and getting in touch with me…. Its great!’

Another UK EMB: ‘I got a business card dropped by KODAK USA and also had a live chat with their senior buyer’

Generating Leads: Evidence From EMBs
At this early stage of data gathering process the expectation was that very few, if any, leads would be gained from the VTF. However, there was evidence that UK EMBs were communicating with businesses and that 7.1% of UK EMBs had actually developed leads, which they suggested were leading to a business relationship. At least 28.6% of UK EMBs had engaged in some early online discussions with the objective of developing a business relationship. The actual relationships, in terms of suppliers or customers, broke down to 14.3% customer (buy-side) relationships and 14.3% supplier (sell-side) relationships supporting the first two B2B models identified in table 1 (Beynon-Davies, 2004). US EMBs
initiated 66% of engagements and 34% by the UK EMBs themselves. Table 7 summarises the ICT technologies used to initiate relationships at VTF:

<table>
<thead>
<tr>
<th>Communication Methods</th>
<th>% usage by UK EMBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>14.30%</td>
</tr>
<tr>
<td>Digital Business Card</td>
<td>7.10%</td>
</tr>
<tr>
<td>Drop Card</td>
<td>7.10%</td>
</tr>
</tbody>
</table>

When live chat forums were used, communication focussed on sharing information about business activities, locations and client profiles. Though some of the businesses were observed to fix chat appointments through exchanging virtual cards in order to formalise the business discussions and follow up business leads. It was also observed in the chat forums, though not commonly used, that businesses were not only talking about each other’s business but were also promoting other exhibiting businesses at the VTF based on their communications.

One such case of live chat forum use was a design and print UK EMB, who was dropped a business card along with a request for an interview by a design company in Philadelphia (US EMB). The initial communication related to an interest in discussing their operations and seeing elements of their work. The relationship developed further via email and then turned to more advanced technologies especially live chat forums. The US EMB wished to explore possibilities related to a business partnership with the UK firm in an attempt to supply their global clients with a presence in the UK. Any development of the partnership arrangement required the maintenance of quality and focus with the UK EMB providing market knowledge. The UK EMB design company was following up on the lead and continued to communicate with the US EMB. As the owner stated:

‘it’s really amazing that some one sitting across the Atlantic talking about partnering with us..... I think its only possible through technology and Internet.’

Of the initiated business relationships 7.1% continued online beyond the closing date of the VTF. The developing relationships were ongoing through e-commerce and e-procurement technologies. The specific objective was to move forward in a B2B context. The B2B activities were all between UK EMBs and US EMBs and not UK EMBs only.

The expectation was that further relationships could develop based on responses from US EMBs. It was evident that the VTF organisers promoted the UK pavilion aggressively creating awareness and interest in UK EMBs. Corporate buyers responses as quoted below supported this:

“I visited the show yesterday and found some interesting companies. I even left a message on the chat line for one company in the UK. I saw a few that my company could use in different states. I’ll forward the information to the Enterprise Buyers and remind them to visit the tradeshow during the ‘live-days’.”

(US Corporation)

“I am personally looking forward to visiting every booth at the UK pavilion and ask my buying team in US and UK to shortlist a few businesses- in fact, I am at this moment visiting one of the UK environmental and waste management companies and
Limited Business Leads: The EMB Perspective
The figures for initiated relationships, previously discussed, are even more significant given the response to the question ‘were you able to find and engage with potentially valuable businesses?’ which drew a positive response from only 41.7% of UK EMBs. The reasons given as to why nearly 60% were unable to find and engage with businesses were as below:

- Difficulties in finding relevant businesses (50%)
- No relevant businesses at all (16.7%)
- Lack of face-to-face communication (50%)
- Time difference between UK and US (16.7%).

The difficulties in identifying relevant businesses are vital as they impact on the development of business relationships and the amount of opportunities created. The difficulties relate to a lack of time to search in detail and an unclear understanding of participant categories in the UK and US pavilion, so in the first instance attendees were unsure of who they may be dealing with and in the second if they were wasting their time. The broad range of sectors was suggested to be an issue as one of the UK EMBs in the food sector stated

‘We tend to be looking for businesses that are in the same sector or market as ourselves. We believe this ensures that any relationship starts off on a surer footing.’

This may be a reason for low evidence from UK EMBs with regards to developing business relations and could have lead to low UK specific B2B activities. Ho et al (2003) in their examinations of virtual markets highlight the need for strategic fit that, they argue is best achieved by businesses in the same markets or sectors.

Different time zones may have also affected interaction between exhibitors and visitors influencing the propensity of developing business relations. The VTF was set up to go live each day from 12pm (9am US) to facilitate dialogue between UK and US businesses with convenience of time. However, responses from UK EMBs online during the show highlighted issues relating to non-availability of US EMBs possibly limiting their ability to find and engage with relevant businesses. There was limited activity by UK EMB exhibitors after 4pm according to normal business hours in UK leaving them with a time window of just 4 hours. The participants thus narrowed the window of opportunity. This provides causal evidence for low uptake of live chat forums limiting the opportunities to foster business relationships.

Finally, the lack of face-to-face communication was raised as a limiting factor in engagement with 50% of respondents identifying this as a factor in reducing their opportunities of interaction. This provides evidence for UK EMBs being less equipped and knowledgeable to utilise live chat forums, audio messages and video conferencing, supporting the view of Rounds (2002) that such virtual environments are not for all. However, none of the UK EMBs identified the lack of face-to-face interaction as a reason to not attend future virtual trade fairs. Therefore the data appears to support the argument that the ICT technology could have provided a solution for face-to-face discussions given the access to equipment and know-how. These findings along with data on EMB exposure and experience to use such technology suggest a need for improvement on the awareness, training, availability and use of the tool. The technology is well used in the US.
The developing relationships were orientated equally around both supply-side and buy-side B2B creating opportunities for EMBS to engage in future e-procurement activities. There was a concern that many potential relationships may not develop due to the low awareness (34% of UK EMBS) and adoption (14% of UK EMBS) of basic e-procurement technologies including involvement in e-marketplaces.

**Conclusion and Recommendations**

Being the first ever UK virtual trade fair and given the identified low propensity of EMBS to adopt and make use of ICT the expectations for any potential B2B activity was very low. Evidence from the gathered data showed only a small number of UK EMBS initiated and engaged in a business relationship. However, there was promising evidence of B2B interactions at VTF creating new opportunities. These were significant given the limited use of all the tools at their disposal along with e-procurement awareness proving low. The later being highly significant given UK government policy to move to and engage in e-procurement at the public level as well stimulating private development. Policy deliverers need to be ensuring that EMBS are not ignored as e-procurement initiatives spread across the UK. Promotion of regional e-marketplaces would be an important entry point. The responses from the US and UK exhibitors about limiting factors for interaction suggested that much could be done to overcome limitations of access to equipment and know-how and foster business opportunities providing policy and training support to overcome:

- Low level use of innovative ICT tools by UK EMBS
- Low uptake of e-procurement awareness and activity
- Low awareness and usage of virtual trade technology
- Low internal B2B activities among UK EMBS.

The reality was that, not all UK EMBS found the Virtual Trade Show useful or valuable however at least 7% engaged in a business relationship and another 21% were involved in early discussions that could lead onto formal business relationships in the future. Positive benefits were also identified one UK EMB owner stated

‘I found the VTF very successful - in fact I had two PCs running at one time... one with the live chat room while I did my routine work on another... its really very cost effective and less time consuming.’

A number of issues impacted on initial engagement activities both for UK EMBS and US EMBS. For the UK EMBS it was a significant learning experience that, in conjunction with their limited knowledge of ICT communication technologies, limited their activities. Given the economic significance of EMBS (Deakins and Freel, 2003) and as a total of all businesses are relatively small in number it is important that Virtual Trade Fairs represent EMBS from the wider population of the UK. US EMBS asked questions about UK EMBS mainly representing East Midlands. Many US EMBS were looking to have the opportunity to engage with businesses from across the UK. There was also evidence that any future shows should be more tightly focussed to ensure businesses operate within similar or related sectors/markets. The narrow generally regional focus of the UK EMBS taking part appears to have reduced the opportunities both for UK EMBS business relationships but also for US EMBS.

‘Initially I find it difficult but now I am enjoying it... this is great.... Its so easy to navigate but in the beginning it feels so weird as you are used to physical shows
where you see people... here you don’t know who is visiting you but when I saw papers, its really great- I will be more happy if this is not restricted to only three days.... I am fascinated and just think what technology can achieve... do inform me when you hold it next time as I will come more better prepared., we need to realize that its an international event and we all should be more professionally prepared.. Our booths should have quality otherwise we will not reach out to US buyers and businesses’ (UK EMB Participant)

UK EMBS need to be better informed and develop their knowledge of ICT utilised in the Virtual Trade Fair environment. The quote above supports this view and was evident prior to the start of the Virtual Trade Fair, with limited booth set up and during the event, where use was primarily limited to electronic business cards and email. US EMBS had at least five years experience in the use of VTFs and were therefore at a major advantage over their UK EMB counterparts. Such experience is important when the businesses you might wish to deal with (US EMBS) are trying to communicate with you through other ICT technologies such as live chat forums. Current EMB ICT adoption and use has affected the approaches of the participants in the Virtual Trade Fair. Prospective participants in the future should undergo experiential training in the higher-level ICT requirements. Therefore a much broader programme of developing transatlantic trade relations between UK EMBS and US EMBS should include the following: Identify sectors these businesses represent; organise sector specific Virtual Trade Fairs; and possibly involve trade and industry intermediaries to bring sector specific businesses to the fair.

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WHO BUILDS “SCIENCE CITIES” AND “KNOWLEDGE PARKS”?

HIGH TECHNOLOGY FIRMS MOBILISING HETEROGENEOUS COMMERCIALISATION NETWORKS

Dr. Paul Benneworth
Institute for Policy and Practice
University of Newcastle upon Tyne
Newcastle upon Tyne
NE1 7RU

“Met grote ogen keek Anton over haar heen. De hagedissen... Was zoiets mogelijk? Kwam het door de hagedissen? Waren de hagedissen uiteindelijk schuldigen? ‘Je bedoelt’, zei hij, ‘zonder die hagedissen was het niet gebeurd?’ ”

Harry Mulisch, De Aanslag, 1982

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INTRODUCTION

The recent failure to deliver the Lisbon agenda has led to much soul-searching within Europe (cf. The Sapir Group, 2005). This failure has enlarged the gulf between the limited number of successful knowledge regions, and those regions for whom globalisation has brought further anxiety, job losses and economic restructuring. More recent Lisbon-inspired policies have therefore attempted to build linkages between successful ‘knowledge islands’ and other, outlying and peripheral places so all can exploit concentrations of European knowledge and innovativeness.

Öresund in Denmark & Sweden, the Eindhoven-Leuven-Aachen triangle in the Rhine-Maas Euregio, and the South Ostrobothnia virtual university all attempt to provide ‘less successful regions’ with access to resources for knowledge-based economic development (Maskell & Törnqvist, 1999; Sotarauta & Kosonen, 2004; Hospers, 2005). Alongside this there has been an increased emphasis on the physical development for the new knowledge economy, creating spaces for these high-technology developments, with science cities, knowledge parks and innovation centres springing up once more across Europe (Hospers, 2005).

This knowledge-based development model begins from the concept that global knowledge flows can be diverted from pools of success into such high-technology spaces in less successful regions. Previous waves of science parks failed to address the core/ periphery gap, booming in the totemic sites of the new economy, and becoming drab office developments elsewhere (Massey et al., 1992). However, new theories of economic development emphasise connecting ‘global knowledge flows’ with local activities, creating a ‘local buzz’ which can stimulate new and innovative high-technology combinations that promote economic growth (Chapman et al., 2004; Hospers, 2004; Bathelt & Boggs, 2005).

There is a need for local innovative capacity to absorb these global resources, and clearly, high-technology small firms (HTSFs) can provide a means to create this ‘local buzz’. In this paper, we consider the way that university spin-off companies
mobilise networks and communities which occupy this physical infrastructure, science parks, learning regions and knowledge cities, and capture and locate ‘global resources’ in these less successful places. Drawing on work undertaken in the old industrial regions of North East of England and Twente, the Netherlands, in this paper I highlight the diverse ways in which HTSFs can place such regions in the global knowledge economy. A dynamic model of community-building is elucidated, and used to reflect on the relationship between HTSFs and knowledge based growth to extend the debate concerning the value of inter-regional knowledge sharing for economic development.

GLOBAL PIPELINES, LOCAL BUZZ? A REVIEW OF THE LITERATURE

There is an increasing acknowledgement that knowledge is increasingly important to the production process. A series of macro-economic studies demonstrates that productivity growth has become increasingly dependent on investments in intangible forms of capital (i.e. not land, labour or machinery), and that ‘knowledge capital’ has increasing returns to scale (Romer, 1994; Solow, 1994; Temple, 1998). Increasing returns to scale suggests that knowledge capital investments will increasingly be concentrated in places with competitive advantages in knowledge production, and the rise of a limited number of mega-cities has been linked to this phenomenon (Smith, 2003).

Although the implicit regional consequences of the knowledge economy are increasing geographical differentiation and competition through innovation, there is some unease that straightforward knowledge capital narratives are unhelpful for understanding ‘ordinary places’ (Armstrong, 2001; Moulart & Sekia, 2003). Moulart & Nussbaum (2005) argue that knowledge capital encompasses resources without ‘economic value’, and that other types of capital – human, institutional and ecological can also promote territorial development.

Such capitals can help to bring new financial investment into those regions, which produce local benefits in what Bathelt et al. term “global pipelines, local buzz” It is not merely the investment which is important, but that the investment allows local actors have some control over its expenditure, and sufficient time is allowed for the benefits to diffuse regionally (Asheim & Herstad, 2005). Cooke & Piccaluga (2005) describe a “regional knowledge laboratory” as various actors bringing external investment into a region which creates unique assets that are of value to their external partners.

A problem for less successful regions is a lack of globally-connected actors able to bring in investments; in such regions, large firms tend to be disinvesting and downsizing. In this paper, we look focus on universities, important components of regional innovation systems, and much more uniformly distributed that either firms or government research laboratories. Drawing this knowledge laboratory concept, LFRs lack strong knowledge exploitation sectors which convert global academic prestige and research grants into premium products and export income. We consider two cases of universities which have attempted to produce their own knowledge exploitation sector by promoting university spin-out companies.

BACKGROUND TO THE STUDY AND METHODOLOGY

In this paper we present two case studies characterised by regionally engaged universities with regional development strategies attempting to exploit those
universities’ capacities. In the North East of England, a partnership of Newcastle City Council, Newcastle University and the Regional Development Agency (RDA) have jointly purchased a central former brewery site for £30m (€45m) on which to develop a new science campus, “Science Central”. In Twente, in the east of the Netherlands, the RDA, the University of Twente, its host municipality of Enschede, and a number of other regional bodies have announced support for a 120ha science park adjacent to the campus, Kennispark. In both cases, the national government has provided moral support without necessarily providing funding or compulsion for the schemes. In both cases, the schemes are currently under development.

In both cases, regional partnerships are attempting to promote university-based high technology growth at a scale not previously achieved. In both cases, a number of relatively small scale successes in university commercialisation have been achieved. These various elements have been combined discursively by regional political actors (including each university) to argue that success is possible on a far greater scale. In this paper, we trace these narratives, to explore whether the elements are likely to combine together at the expected scale. We begin with looking at the novel regional capacities produced by commercialisation, particularly in terms of regional networks of high-technology small firms which have mobilised around each university.

**University of Newcastle, North East of England**

The North East of England underwent industrialisation from the late 18th century, and has experienced a century of industrial decline in which it became dominated by mature mass production businesses with little indigenous entrepreneurship. Newcastle University was formally created in 1963 from King’s College Durham itself formed in 1937 from a specialist marine engineering and agriculture college and schools of Medicine and Dentistry (Loebl, 2001). Agriculture, medicine and engineering were all applied subjects, and King’s College reflected this disciplinary mix in its ethos as “a place of useful knowledge” (Potts, 1998). Despite a prevailing isolationist academic norm and successive UK governments discouraging university/regional engagement from the 1940s to the late 1970s, Newcastle-based academics maintained industrial contacts throughout this period (Potts, 1998).

After 1979, the new European Regional Development Fund ‘non-quota’ (i.e. community-wide) policies were based upon mobilising indigenous business assets for innovation. With few private or governmental R&D organisations active in the North East, the Department of Trade and Industry and local authorities demanded the universities become actively involved in regional engagement (Benneworth, 2002). This initiated a stream of activities as Newcastle University expanded its regional engagement, including a Micro-Electronics Applications Research Institute (MARI, 1983), an City Technology Centre (1984), a seed capital fund (NUVentures, 1987), a regional development office (1995) and finally, a Business Development Directorate (2003). By 2004, regional engagement had become central in two key institutional documents, the Business Plan and the Estates Masterplan.

**University of Twente, the Netherlands.**

The Twente region industrialised in textiles and supporting machinery after 1830, and after WWII entered a period of secular decline, which by the 1970s had become a crisis. The Technical Polytechnic of Twente (THT³) was created in 1961 to increase technical graduate numbers, promote regional textiles renewal and support the Dutch transformation into an advanced manufacturing economy. However, as the 1970s
textiles crisis unfolded, the Government seriously debated closing THT and refocusing scarce public resources on more successful regions and industries (Groeneman, 1991).

Under the leadership of Harry van der Kroonenberg\(^2\), the university reinvented itself, changing its name to the *University of Twente* (UT) and rebranding itself as “the entrepreneurial university” in 1985. In parallel, UT pioneered a series of institutional innovations, including a technology transfer office (1979), an incubator unit (1982), student entrepreneurship schemes (1985), knowledge circles (1990), regional venture funds (1996), an open innovation centre (1997) and a “technology accelerator” (2003). These resources made UT a central partner of the provincial government and regional development agency, who now seek to extend and generalise the last quarter century of high-technology growth.

**Study Methodology**

Each regional case study involved two elements, a review of regional information sources and a set of key respondent interviews. A wide range of documents were reviewed, including historical and contemporary reports about both universities and their regional contexts, along with contemporary policy documents and strategic plans from the university, regional partners and the national government\(^4\). 75 face-to-face interviews were undertaken in the two study regions, 32 in Newcastle and 43 in Twente\(^5\) undertaken through a snowball approach (cf. Yin, 1994)\(^6\). These interviews included 16 spin-offs in Newcastle and 24 firms in Twente, with the remainder a mix of university management, academic and commercialisation staff, and key regional stakeholders including regional development agencies, networking organisations and representatives organisations. The study took place within the framework of an ESRC project “Bringing Cambridge to Consett?”.

**HIGH TECHNOLOGY SPIN-OFFS MOBILISING REGIONAL COMMUNITIES**

It is widely acknowledged that high-technology entrepreneurship is heavily dependent on networks (e.g. Groen & Jenniskens, 2003). It is unsurprising that spin-off company formation, a quintessentially high-technology form of entrepreneurship, involves assembling and drawing upon a range of networks proximate to the particular spin-off entrepreneur (Benneworth & Charles, 2005). However, pace Dahlstrand & Jakobsson (2003), in the two case studies, the spin-offs’ network activity did not decline after leaving the university. A number of university spin-off companies (USOs) contributed more to these networks post-formation than ante-formation. In this paper, I distinguish six regionally articulated networks. These networks involved universities, spin-offs and regional partners, and spanned between the university and the region.

1. **Providing direct support for academics**

The first networks were the connections the spin-offs provided back to the professors who formed the companies. In Newcastle, the dominant model of entrepreneurship meant that in many cases the professor was still actively involved with the spin-out. In Newcastle, a particular technology subsidy, worth around €100k allowed spin-offs to undertake novel research, and the instrument technicalities made it least risky for small companies to spend it with an academic collaborator; thus, spin-offs generated third-stream income for their professors, and those commercial problems disid
stimulate innovative blue-skies research attractive to science funders. In Twente, although a similar instrument has been introduced now in the Netherlands, at the time of the research it had not, and so the main discovered form of interaction was spin-offs as users of science projects. For a 10% contribution to a project, the firms were involved with a user committee; because STW grants are evaluated partly on their dissemination plans USO involvement helped win projects and bring funds to the university.

Other spin-off/academic linkages existed; in both regions, spin-offs employed post-graduates and post-docs; in cases in both institutions, a post-doc moved to work for a USO but maintained an academic relationship with the professor. In one case, a spin-off found his professor a useful source of graduates; when the professor retired, he mobilised a community of employers who funded the university (c. €50k annually) to maintain this employee source. In some cases, students worked alongside spin-offs on student research projects; many USOs were exploiting inventions which emerged within such projects. One research group had a practice of contacting key firms (including ‘their’ USOs) when they found potentially commercialisable things peripheral to their main research; they described as “throwing [the ideas] over the fence” to them. There were also informal connections; in every single USO, there was some active link back to the university.

2. Mobilising soft networks

A second set of activities was where USOs helped to develop soft networks whose presence helped other spin-offs and high technology small firms to succeed. UT had a number of excellent examples of where USOs themselves had come together and mobilised; a number of companies interviewed had been involved with TIMP.

- TIMP was a group of HTSFs funded by a local development agency on collaborative innovation projects in medical technology (Klein Woolthuis, 1999). This organisation succeeded, and a number of other projects emerged including the sector being designated a strategic thematic area in the regional science council (the Innovation Platform).

- Twente Technology Circle was launched by UT itself to help its spin-offs sell to large regional companies, but evolved over the years into an networking and mentoring organisation, under a steering group at the time of the research comprised entirely of TOP companies and a university representative.

- Technology Exchange Cell: a virtual product development laboratory at the university, stimulated by a large regional firm but whose realisation and rapid prototype capacities were provided by spin-offs from the university.

By contrast, in the case of Newcastle, there were much fewer academic entrepreneurs who were involved in stimulating networking activities in the region. Although a biosciences network was established (Bio’NET) by someone who subsequently established a USO, the region seemed somewhat behind Twente in terms of establishing supportive networks. There were key individuals who provided access to one-off advice/guidance, and the university began to systematically engage with these key advice providers. The Alchemists was an organisation created by three retiring business service professionals to try to stimulate entrepreneurs to grow through using professional advice more effectively. Newcastle University approached their chief executive to sit on their Equity Committee which oversaw the formal
technology transfer process for university IP being spun-out. Other key regional entrepreneurs with their own networks were recruited to sit on key university committees including the Advisory Board for the Business School and committees dealing with other aspects of regional engagement.

3. Stimulating financial resources

The third area set of networks where USOs in both regions were active was in stimulating the creation of regional venture funds. Both institutions in the early 1990s had invested in a few companies, and some of those investments had proven successful. On that basis of that experience, universities in both regions had engaged with regional development agencies to help them create regional venture funds to meet USOs’ needs. Those funds’ creation was in turn justified by those previous successes and ongoing university commitment to spin-off creation.

Newcastle University had created a specific fund in the early 1990s to invest in spin-off firms, but this had largely disappeared without significant impact (Potts, 1998). What was significant was that one pharmaceutical USO had granted the university a share; the company was sold in 2002, and the university received a £6m (£9m) ‘windfall’. Immediately previously, the university had failed to invest in a computer security company which had been sold for $14m (£12m) and so failed to receive a windfall. The university in 2002 produced 6 spin-out companies and at the time the RDA were creating a high-technology regional venture fund. Newcastle University used these various facts to persuade the RDA to create a special instrument, the proof of concept fund, which was tailored to the needs of USOs.

In Twente, by the mid 1990s, the TOP scheme had been functioning effectively for a decade, and demonstrated that the university could produce companies which would grow near to the university. The regional development agency, UT and the nearby Polytechnic together created and capitalised Innofonds, a regional venture capital fund. This raised €11m which was invested in two tranches in around 30 companies, and although it became caught up in the bubble economy and some investments failed, it was a reasonable success; when the RDA merged with a nearby organisation, they created a joint holding company with the apparent intention of raising more funds and investing in high-technology ventures in the east of the Netherlands.

4. Making commercialisation supportable

The fourth area where USOs built a community was in contributing to making commercialisation a core university function. Although both universities liked the idea of getting additional so-called third-stream funds, in both places there was ongoing resistance to spending core university funds on central activities such as technology transfer offices which supported those activities. USOs in both regions became an important part of persuading universities that commercialisation was worth investing seriously in. It was not just that they helped academics win more research funding or that academics were lured by the financial rewards from selling off successful businesses. USOs also became involved with the core missions themselves and showed that commercialisation could help both universities achieve their teaching and research missions.

One key example of this was that USOs became involved in larger infrastructure developments which supported core university research and levered in external funds. There were a number of examples of these large multi-million euro projects, which
won large subsidies partly on the basis of scientific excellence, and partly on the basis of expertise in commercialising that expertise. USOs were been involved in a variety of ways, but critically helped to demonstrate that UT and Newcastle were good at commercialisation. Both governments increasingly emphasised science commercialisation, so positioning both universities to win large grants, which have in turn funded core academic research facilities.

- International Centre for Life (ICiL): a life-sciences campus based on a £50m lottery award and a £10m science infrastructure fund award, integrating university genetics research (medical and sociological) with hospital genetics services, and commercial genetics companies including USOs.

- Institute for Nanotechnology Exploitation (INEX, Newcastle): originally a professor funded out of university funds to integrate existing research strands; won RDA start-up funding; then won a £7m DTI grant followed by another £10m of infrastructure funding for nanotechnology.

- MESA+ (Twente): nanotechnology was a field where the university had produced some early spin-offs; a joint academic/ commercial laboratory facility was developed for nanotechnology including consultancy activities (now spun-off); in first ten years of life, has produced 30 spin-offs and has own small development fund; co-ordinates the Nanoned Science Exploitation Programme (£50m).

5. Producing new growth sequences

A fifth area where the USOs contributed to new regional networks was a number of the entrepreneurs involved in USOs subsequently becoming serial entrepreneurs and founded other companies producing sequences of growth. In Twente, four of the interviewed entrepreneurs were involving in diversification through setting up network businesses and joint ventures within an overall holding company structure; there were around 250 jobs in this four company originating sequence. In Newcastle, the very successful pharmaceutical spin-off spawned three daughter companies on the basis of the cash produced from the sale of the company. One medical spin-off had set up a number of subsidiaries as a means of testing new markets whilst minimising risk. The design team of an engineering USO left and set up their own business, and they both grew to employ over 50 people by the time of the research. This suggests that the networks formed from USOs had a degree of vitality and dynamism, and were not just self-employed academics anchored around the university.

Perhaps more interesting is the role of USOs in helping traditional companies in mature sectors to reinvigorate themselves and become more engaged in high technology sectors. In both life sciences and nanotechnology, there were a number of North Eastern mature chemicals companies working with Newcastle USOs as part of successful attempts to move into new markets; one company spun off from its parent and now employs over 60 staff, and there are around 200 employed in science-intensive biotechnology jobs in formerly mature chemicals businesses. In Twente, there were a number of branch-plants in the region whose survival within the corporate structure was dependent on maintaining unique knowledges that other parts of the business could not copy. A number of those branch plants had working relationships with spin-offs as well as the university to try to sustain their unique corporate capacities (cf. Technology Exchange Cell).
6. Stimulating regional technology policies

The final area where spin-offs mobilised networks was around emerging regional science and technology policies. Benneworth & Charles (2005) identified that spin-offs have a role to play in working with regional science and innovation policymakers, improving business support’s quality and relevance. In both regions, RDAs were apparently sensitive to spin-offs’ needs, creating new programmes such as the high-technology venture funds. However, there was some evidence that much of the needs sensitivity was passive i.e. RDAs looked at spin-outs and decided what ‘they needed’ rather than working interactively with them.

There were more interactive approaches; in Twente, the RDA Technostartners programme drew very heavily on the experiences and academic knowledge built up through the TOP programme. The TOP concept was diffused and extended into other contexts including a remote rural area and a college of middle professional education. In the North East, the RDA allowed the regional universities to administer their proof-of-concept fund, acknowledging that their commercialisation expertise was as effective as anything they could assemble.

There are some examples of how USOs did become directly involved with reconfiguring policy in support of spin-offs. In Twente, one USO entrepreneur was appointed to the Regional Innovation Platform, albeit as a successful entrepreneur rather than as a USO representative. One 1980s spin-off entrepreneur ran a state-funded seedcore fund to the south of Enschede. In the early 00s, the RDA encouraged micro-clusters of high technology businesses to come to them, funding several collaborative partnerships, many involving USOs in leading capacities.

There was less apparent involvement in the North East of Newcastle USOs shaping the regional environment. The national Industry ministry (DTI) became aware of a problem with tax rules which was to stop spin-outs for 18 months because a non-executive from a North Eastern USO (not from Newcastle) informed them of the problem. Although the North East did build a somewhat Byzantine regional science policy apparatus, the so-called “Strategy for Success”, USOs were only ever peripheral to the structure.

TOWARDS A COMMUNITY BUILDING MODEL: USOS AND POPULATED SCIENCE PARK CONCEPTS

But how do these various contributions and communities come together to mobilise the idea that a ‘science park’ policy is of regional significance? This can be considered as a process of stabilisation over a long-term period:-

- high-technology spin-offs demonstrate that high-technology entrepreneurship can be made to work in a place,
- this shows universities have further potential which can be exploited, and
- the growth trajectory of USOs shows that a ‘science park’ arrangement is the appropriate way to manage knowledge exploitation.

This is the basis of the community building model: something experimental, small scale and indeterminate becomes common practise, large scale and precise. This makes external partners willing to support and invest in the ‘science park’ concept. It is possible to highlight four stages in this translation process, with at each stage, the
contributions made by USOs playing a role in the outcome, whether the next stage can be progressed to and what the impacts of those changes are.

**Experiments in entrepreneurship**

The first stage in the model is when the university begins with its experiments in entrepreneurship, and the first USOs emerge from the university. This may be as a consequence of the university launching a scheme such as the TOP programme, or announcing, as Newcastle University did around 1990, that entrepreneurship was something that professors should be doing and providing a service for interested academics. The key determinant in successfully progressing to the next stage is whether producing spin-offs appears to have unrealised potential which could further be exploited. The runaway success of TOP and external interest in Newcastle University’s spin-offs both suggested that there were further capacities for action.

If the scheme is a failure in its own terms, then it is likely that the university will abandon the scheme once funding for the programme expires. However, there is also a scenario where the scheme might succeed in its own terms, creating businesses, jobs and other outputs, and yet fail to lead to progress to the next stage; in both institutions, when schemes failed to demonstrate a clear potential to link to core teaching and research missions, then such schemes were either periodically abandoned or became the preserve of isolated individuals with little institutional mandate to continue the projects. Facing such institutional apathy, it is hard for individual projects to survive.

However, if spin-offs are dramatically successful, then it is possible that they will offer the university an opportunity to produce core teaching and research benefits from them; both universities saw USOs had a potential to bring in external resources which could be invested in core scientific infrastructure. At that point, both universities became interested in finding more generic structures making spinning-off companies more institutionally rooted.

**Institutionalising academic entrepreneurship**

A common strategy for embedding spin-offs more firmly within each institution was creating specific hybrid institutes where spin-offs, research groups and other commercial partners could interact around a shared set of facilities. Such institutions allowed spin-offs to benefit from the presence of academic infrastructure, and academics to benefit from the presence of a commercial-quality infrastructure. Cost-sharing between academics and companies, for example, could be used to underwrite investment in large capital facilities which increased the scope of work potentially undertaken by particular research groups.

Building such facilities required demonstrating two key points, firstly that there were clear academic benefits in investing core resources in such facilities, and secondly, that there was a steady stream of spin-out companies emerging which would continue to lever in additional resources to support ongoing academic research programmes. Again, USOs’ previous collaborations with university research groups and their demonstration that university spin-out activities were successful helped to justify the creation of ‘hybrid institutions’ such as MESA+, ICfL, the BTC and INEX.

Those hybrid institutes were not always successful. There were examples of ‘institutes’ in both institutions that did not succeed either in terms of their commercial mission or their academic mission, and obviously, such failures tended to be rapidly closed down or ‘merged’ into more successful organisations. Some institutes were
successful in terms of the commercial mission, but did not contribute to core academic missions; those activities tended to be spun-off or privatised, because of the difficulties that higher-level teaching and research institutions have managing other types of activity. Those hybrid institutes which have been successful were those which helped to win external funding for academics; this was often translational R&D type funds which could be spent on fairly basic research. The funds were often justified because each university had successfully ‘applied’ basic research, demonstrated by the spin-off companies. Because both universities had been able to make the institute-type model work on at least two quite different occasions, both universities attempted to rebuild themselves organisationally to improve their capacity to produce a stream of these hybrid institutes, and hence lever in significant external funds which underpin their core academic missions.

Building an entrepreneurial culture

The next stage of the process was building an entrepreneurial culture within the university, in the sense of a set of capacities to develop a stream of hybrid institutes. This institutional change involved reorganising research groupings to be more ‘marketable’ to external partners, forcing academic structures to accept commercial income targets and making looking for hybrid institutes a key part of the central and faculty business planning process. Both universities drew on their capacities and knowledges built up in spinning off companies to achieve a cultural change. These capacities and knowledges were arguably still held within a community still involving the spin-offs. Although this appears to be an issue of institutional management, in both cases USOs were involved in helping with this institutional change. Spin-off entrepreneurs were involved in a variety of ways in the technicalities of university cultural change, advising universities, bringing them good commercial opportunities, and implementing new structures.

Both institutions had taken some time to reach this position; much of the pioneering work of Harry van der Kroonenberg at UT was not driven forward by subsequent Rectors, and at Newcastle, previous Vice Chancellors had built entrepreneurial capacity within their executive offices without trying to coerce other academics to become entrepreneurial. What appeared to make the difference in the latest phase was the scope and the terms on which the university engaged with an external community, including USO entrepreneurs.

On those occasions where cultural change had been attempted but had not taken root, entrepreneurs and universities had ‘spoken at’ each other; this latest phase of engagement involved the two parties entering into each others’ confidence and working together towards a common goal, becoming an entrepreneurial university. This goal was clearly only for the direct benefit of the university, and so finding entrepreneurs to become trusted university partners was a difficult issue. USOs were a good source of trusted university partners because of their variety of personal, social and commercial linkages back into the universities.

Reconfiguring regional partners

The final stage of the process was that regional partners acknowledged that each university was entrepreneurial, with considerable untapped potential for further commercial exploitation, and was sufficiently well-managed with experience and
capacity in the particular area. In Newcastle, the regional development agency had proposed and invested heavily in a number of science projects which could not effectively be stabilised into a regional innovation system. Thus, the RDA engaged enthusiastically with the university’s own regional science concept, rebuilding the campus as a set of hybrid institutes (Science Central). In Twente, a number of regional partners adopted the Kennispark concept in 2003/4 and implicit endorsement of the concept through the national spatial economic strategy (‘Pieken’) effectively made an extension to the science park an obligatory point of passage for Twente’s regional science council (the Innovation Platform).

In each case, regional partnerships were mobilised which agreed in principle to fund large scale strategic investment projects, Kennispark in Twente and Science Central in Newcastle, with tens of millions of euros. The partnership funding idea recognised the regional value of a university able to produce a series of hybrid institutes. The regional value of these hybrid institutes was in accelerating the numbers of spin-offs; spin-offs had regional economic value because of their visible direct and network contributions. USOs were important both symbolically as ‘claimed successes’ by the university, but also ‘trusted partners’ (including USO entrepreneurs) were important in helping RDAs to believe the high-technology fantasies underpinning the strategic projects.

**TOWARDS A MODEL FOR COMMUNITY BUILDING**

In figure A below, we graphically represent this process as a flow chart. At each stage, USOs provide capacities which the key mobilising actor, in this case the university, draw upon in order to draw to the next stage. If there are not suitable sufficient capacities, then progress is not possible, and the developments which have been achieve either collapse or wither; unsuccessful projects are abandoned, peripheral institutes are privatised, or commercialisation targets withdrawn. I argue that in the two study regions, what has happened is that three sets of barriers have been overcome, making a sufficiently compelling case enrol regionally investors in hybrid science parks.

[FIGURE A GOES ABOUT HERE]

In figure A, the USOs are only explicitly visible in the first phase, where they are the result of a commercialisation project whose success enables a series of subsequent developments. However, looking more closely at the two case studies, it is clear that USOs have been involved at each stage. USOs have helped universities address the problems at each stage, and to ensure that the institutional trajectory moves from the ‘failing’ or ‘weak’ trajectories to the ‘strong’ trajectory. This implies that USOs are indeed important in the process of progression from vulnerable entrepreneurship projects to a ‘regional science park’ concept. The contributions at each stage are as follows:-

- Firstly, the spin-offs help to make particular entrepreneurship projects succeed; individual entrepreneurs establish businesses, there is mentoring within and between cohorts and results are produced for the projects.
- Secondly, spin-offs help to make particular hybrid institutions attractive for other investors; on the one hand, they are a rationale for investing to create a critical mass, on the other they are interesting partners and sources of ideas and employees for other investors.
Thirdly, spin-offs become involved in helping universities develop the structures necessary for entrepreneurship, including running investment instruments, developing incubator activities and facilitating reorganisation.

Fourthly, spin-offs help to enrol external regional partners by telling them of the value of commercialisation undertaken at the university and its ongoing capacities to exploit its wider knowledge base.

There is therefore a process of co-evolution between the universities and the spin-off communities in the two examples presented. On one side, the spin-offs are evolving from small standalone companies into significant regional actors; on the other, the universities have evolved from institutions spilling knowledge into their localities into institutions with strategic plans for commercially disseminating their knowledge locally. The result of the coalition is that other local actors create a place where those two activities can take place in parallel, that spin-offs can be actively stimulated, namely the science park.

The consequence of this is that in each case the science park is much more than a piece of real estate. The \textquote{science parks} (Science Central and Kennispark respectively) are a series of relatively stable and certain activities and capacities (spin-out, incubation, mentoring, venture finance, urban regeneration) which are being combined together in an innovative and plausible way. It is by no means certain that the projects will succeed, but the two concepts being developed in the two regions appear to have a considerable advantage with respect to the failed \textquote{high technology fantasies} of the 1980s, in that they are not beginning \textit{de novo} – the science park in each region is a natural extension of tendencies and capacities already proven and demonstrated.

Of course, such science parks are neither regional knowledge laboratories nor are they fully fledged regional innovation systems. The fact that both universities have worked for twenty years promoting innovation emphasises the difficulties in promoting new regional innovation systems. However, these new science parks are interactive, hybrid spaces where a range of capitals come together, and could conceivably provide an arena where local buzz could be created and spread out across the region.
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Figure 1 A model of community building with high-technology small firms and universities

START
Experiment with spin-offs

Do the experiments produce benefits for the university?

Yes
STRONG
Managers see more potential

No
FAIL
Experiment abandoned

WEAK
Activity becomes marginal

Peripherally
‘Institute Building’

Do external actors believe the ‘high technology fantasies’?

Yes
STRONG
Regional Partnership forms

Peripherally
Regional Science Park

No
FAIL
Institute disbanded/reorganised

WEAK
Institute is privatised

Peripherally
‘Becoming Entrepreneurial’

Does the institute produce core scientific investment?

Yes
STRONG
Managers try to shift culture

No
FAIL
Institute is privatised

WEAK
Compromise project

‘Institute Building’

No regional community

FAIL
No regional community

Source: authors’ own design
1 THT is the abbreviation derived from the Dutch name for the institution, Technische Hogeschool Twente. Although literally meaning Technical High School, the Hogescholen are now part of the higher education system as Universities of professional education alongside the Scientific Universities. However, despite the name, THT was created as a technical university rather than a university of professional education.

2 The position broadly equates with the position in UK universities of Vice Chancellor; however, the governance arrangements in Dutch universities are somewhat different to UK universities. UK universities are traditionally governed by an academic body such as Senate, which appoints the senior managers drawn primarily from promoted professors. In the Netherlands, universities have a small executive board, which reports to (and is appointed by) a supervisory board of stakeholders, including academic representation, but also the government and the Ministry of Education. The Rector Magnificus is the senior academic representative on the executive board with responsibilities for teaching and research; the other positions will typically not be academics and have responsibilities for finance, estates, regional engagement and internationalisation. In practise, there has been a convergence of these two systems as both Dutch and UK universities come to terms with very similar external pressures.

3 The most famous of these, about which a great deal has already been written, is the so-called TOP programme, from the Dutch name, Tijdelijke Ondernemers Programma or Temporary Entrepreneurs’ Scheme. The scheme is open to anyone with a business plan to exploit technologies and know-how in university research groups; in practise this restricts participation to recent graduates and people working in companies that have research collaborations to the university. This scheme has existed since 1985, although it has been tweaked in response to experience and the changing demands of funders.

4 Those documents directly cited in the paper are included in the bibliography; a full list of documents reviewed is included in Benneworth (2005).

5 More interviews were undertaken in Twente because I did not have a good understanding of the regional development context in Twente, whilst I had just completed a research project on regional science policy in the North East England which provided comparable contextual information for the North East.

6 I consulted with academics in each institution with a knowledge of spin-offs to identify a core of interviewees, and then the same was extended outwards approaching people recommended by the initial interviewees.

7 as one academic professor noted “The company will pose a question to me, as research director, ‘that represents a 30% loss of productivity over the entire year, what can you do about it?’ And the answer has turned out to be very, very interesting … There are two things. Firstly, how can you devise solutions, and I tend to go to the DTI and say if we could devise a method … this would increase productivity by 30%, increase profit, lead to growth, so many more people would be employed so we’ll try and do that with them. Then you go to the scientific literature and you ask, is there any scientific or any knowledge or mechanisms for measuring [what controls productivity] … you can then devise a programme of pure research to try and get at the mechanism”.

8 In the mid-1980s, both universities had received significant government funding to establish micro-electronics consultancy centres to help local SMEs adopt new technologies; both centres grew very rapidly on the basis of local demand, but once the funding expired, in each case the university felt that it was employing people (and incurring risks) that added nothing to core teaching/research missions, and so those institutes were privatised, and became spin-off companies.

9 Newcastle University received a £3m grant from the Department of Trade and Industry for the Nanotechnology Manufacturing Initiative which was explicitly justified in terms of Newcastle’s success in producing spin-outs. Likewise, the position of UT as the centre of the Dutch Nanoned programme was a consequence of both the scientific excellence in MESA+ but also the fact that spin-outs from UT had been very important in the predecessor programme, Microned.
Post-Project Market Review as a tool for stimulating commercialisation of knowledge creation projects

Liesbeth Y. Bout¹, Jaap H.M. Lombaers², Efthymios Constantinides³, and Petra C. de Weerd-Nederhof³

¹ Capgemini Consulting Services, PO Box 2575, 3500 GN, Utrecht, The Netherlands; liesbeth.bout@capgemini.com
² TNO Industrial Technology, PO Box 6235, 5600 HE, Eindhoven, The Netherlands; j.lombaers@ind.tno.nl
³ School of Business, Public Administration and Technology, University of Twente, PO Box 217, 7500 AE, Enschede, The Netherlands; e.constantinides@bbt.utwente.nl; p.c.deweerd@utwente.nl
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Post-Project Reviews are mainly used as a tool to improve organisational learning (Busby, 1999; von Zedtwitz, 2002). However, the concept of post-project review can also be used as a tool to identify new market potential and to hand over technical knowledge from technical to marketing personnel (von Zedtwitz, 2002). This paper presents the findings of a research project on the improvement of commercialisation at a research organisation. After the problem analysis, a session based on the concept of post-project reviews is introduced as one of the potential solutions to improve the commercialisation of knowledge creation projects.

1. Introduction

This paper handles about the introduction of a post-project market review, which is based on the concept of post-project reviews to stimulate commercialisation. It will start with a brief description of the case-company. After this, the motives of the research will be clear and the research methodology will be explained in chapter 2.

1.1. Case-company

The case-company is a public-funded Dutch research organisation for applied-scientific research. Its mission is to generate knowledge based on scientific research and develop applications with the aim of strengthening the innovative power of the industry and the public sector.

The government finances the research done Industrial Technology either wholly or partly and public funding makes about 30% of the institute’s budget. The fundamental knowledge-creating projects with governmental funding have the duration of one year, during which the financing of the project is guaranteed. After that, a follow-up project can be started for further development of the created knowledge and additional funding is possible. If projects get more application-oriented, they must be increasingly financed by the industry (figure 1).
1.2 Problem definition

Past experience indicates that a considerable part of the knowledge created in the more fundamental, governmental funded projects remains unused by both government and industries. The consequence is that this knowledge cannot be used for creating value and gain commercial funding that would strengthen the innovative power of industry and government. The purpose of this study is to investigate ways to increase the number of knowledge creation projects that are commercialised, becoming the basis for innovation or further research by the industry.

2. Research Design and Methodology

The research is divided in two parts: In the first part, the study was focused on analysing the problem and defining its dimensions. After defining the parameters of the problem, several alternative solutions were considered; one of these solutions was the introduction of post-project reviews. This possible solution was further investigated in the second part of the research; therefore, three research questions are formulated: 1. What is the right structure of the post-project review session? 2. What is the effect of the structure on the preparation and follow-up of the post-project review session? 3. How should the post-project reviews be introduced in the organization?

Documentation and relevant theories in combination with the knowledge obtained by means of interviews were the main sources of information necessary for answering these research questions. Subsequently, ten pilot-sessions were held; the sessions were analysed and a survey was held among the participants of each session. The results of the analysis and the resulting knowledge became the basis for the final design of a methodology for the post-project review process. The drafted methodology was presented to the management who decided to implement it in all publicly funded knowledge creating projects.

3. Problem analysis

The first part of the research focused on analyzing and structuring of the motive of the research study: the lack of commercialization of governmental funded projects.

3.1 Value creation

The process of value creation consists according to Anderson and Narus (1999) of three phases: Understanding value, Creating value and Delivering value. Applying this model to a research institute implies that knowledge is the value created. This knowledge is generated in knowledge creating projects identified in the first stage of the process (understanding value). Delivering value implies the created knowledge-value finds its way to the market by means of commercialisation.

The reasons for failure to commercialise all knowledge created by the institute can be traced in each of the three phases of the value creation process (Anderson and Narus, 1999). Problems arising in the “understanding value” phase can result in selecting projects of questionable technological interest and market potential. If problems arise in the “creating value” phase, the projects can suffer from poor execution, and if problems arise in the “delivering value” phase the resulting innovations are not successfully brought to market.

3.2 Causes of limited commercialization success

After analysing a number of the institute’s projects in combination with employee interviews, the institute appears to be focused on the creating value phase while not enough attention is paid to understanding and delivering value phases. This conclusion is based on the fact that many projects either lack a clear market focus (understanding value phase) and/or limited attention is paid to reach the customers interested in utilizing the knowledge (delivering value phase). In other words, technological aspects are receiving much more attention in relation to market
aspects. This can be attributed to a variety of reasons; important ones are the internal technology-centred culture ignoring market needs and the lack of a consistent approach towards the value creation process from idea generation to market introduction (Kotler, 2003).

3.3 Increasing market focus and awareness

Increasing the number of successfully commercialised knowledge-creating projects, requires that the organization changes its attitude as to the way it deals with the market and the customer needs as well as increasing peoples' awareness in the knowledge creation process. A way to stimulate such an attitude change is to encourage researchers to discuss not only the technical but also the commercial aspects of the application and pay special attention to the market potential of the project or set of projects. This requires thorough market orientation in the initial stages, resulting in a roadmap and thorough analysis of the results of each project, in order to map the next and future steps (figure 2). With regard to the results analysis, a post-project review seems to be the proper way to achieve this. Currently, the institute doesn’t apply post-project reviews. There are however reviews in between and the project managers are required to fill in a review form afterwards. The accent on these reviews is at the execution of the project (time, budget, risks).

4. Design Knowledge-Application Discussion

The design of the knowledge-application discussion process consists of a session and the preparation and follow-up of this session. Choices need to be made regarding the participants, the facilitator and the way to structure the session itself.

4.1 Post-Project Reviews in Literature

In literature post-projects are mainly suggested as tools to facilitate and initiate organisational learning (Von Zedtwitz, 2002). Busby (1999) concludes that post-project reviews are important learning tools, whose value is often underestimated. The post-project review is one of the most important, most structured and most broad applicable ways to transfer knowledge (Von Zedtwitz, 2002).

Most organisations seem to lack a structural approach towards learning from past experience of projects. Even projects stopped prematurely aren’t always reviewed. A survey (von Zedtwitz, 2002) shows that 80% of the projects aren’t reviewed afterwards, 20% is reviewed but without clear guidelines. Interim reviews are not uncommon, while many post-project reviews are only focused on technical aspects or skipped due to time and management restrictions (von Zedtwitz, 2002). The importance of post-project reviews and the fact that few organisations regularly carry them out is often underlined in the literature.

According to von Zedtwitz (2002), post-project reviews should focus on obtaining process information for future projects. The main goal is to initiate and facilitate the continuous learning on all levels within the organisation (focus on double-loop learning), which is crucial in R&D organisations. However, learning from reviews doesn’t have to be restricted to the lifecycle of the project. Von Zedtwitz (2002) gives an example of a post-project review in which new market potential is identified while at the same time technical knowledge is transferred to marketing employees. This is similar to the role the post-project review should be able to play for the institute.

Regarding the structure of the post-project review session, the approach chosen depends heavily on the existing company culture and underlying motive for conducting post-project reviews: different objectives and needs, different markets and industries, different cultural contexts, and different degrees of innovation all influence the way post-project reviews need to be conducted (von Zedtwitz, 2003).
4.2 Multiple objectives

The main underlying motive to conduct the post-project market review in this case is the commercialisation of the projects’ outputs, however, the institute doesn’t have an explicit strategy on the way projects must be reviewed in order to contribute to the organisational learning. Therefore, the post-project review might have multiple objectives:

- Formal closing of the project by reviewing the course of the project for organisational learning.
- Discussing the application and commercialisation issues of the project as well as formulating the necessary course of action.

Of course, discussing the application and commercialisation of projects’ results is something that can be done also before and during the project. However, doing this in a structural way at the end of a project ensures that this step will not be omitted when the deliverables of the project are fixed. Besides, the probability that action decided and agreed during the session will be carried out increases when the project is over, since project activities will disrupt the agreements made.

The added value of this session based on the above premises, compared to the current situation, can be summarised in the following elements:

- The approach is compulsory and uniform for the entire institute
- Learning by reflection
- Identification of possibilities for application and commercialisation of the projects’ results. These can be the input to the follow-up project.

Finally, the institute wants to introduce assessments for all projects. The post-project review seems a good occasion for this assessment. However, this can cause problems because the assessment can cause people feel bounded and are not honest and open about e.g. problems that appeared or about the potential of the projects’ results.

4.3 People involved

In order to reach the objectives of the sessions, the appropriate people need to be involved. In the case of learning by reflection, von Zedtwitz (2002) makes the distinction between three levels of learning: individual, team/group, and organisational. A post-project review focuses on the learning between individual and team/group or/and the learning between team/group and the rest of the organisation. For the learning between individual and team/group, the entire project team needs to be present. For learning between team/group and the organisation, the acquired knowledge within the team needs to be transferred outside a team. This can be done in several ways. An effective way appears to be the presence of an outsider at a post-project review (Busby, 1999; Von Zedtwitz, 2002). The outsider can be a project manager of similar project or someone of the department Knowledge Management. Knowledge Management can be an intermediate between the post-project reviews and (top) management.

The second goal, the commercialisation, requires some other participants, e.g. customer manager, marketing manager, or group manager. In the case of TNO Industrial Technology, the technology manager and sales manager should be involved. The technology manager has the overview over the (portfolio of) knowledge-creating projects (technology push); the sales manager is responsible for retaining the current customers and acquiring new ones (market pull). Together they can deliver a positive contribution to business development (figure 3).

Conclusively, the following people should be participants of a post-project review session:

- Project team (including project manager)
- Technology manager of functional department
- Sales manager of functional department
- Representative of staff department Knowledge Management
- Others, e.g. project managers of similar projects or the department manager

Figure 3: Role of sales manager and technology manager

This group of people is quite large and therefore needs to be reduced. As commercialisation is the most important goal, it’s not required to involve the entire project...
team, only the key players are sufficient. Consequently, an additional meeting is required to facilitate the learning between individual and team/group.

4.4 The facilitator

The course of the session depends largely on the facilitator. The facilitator can be the project manager or e.g. an outsider. Provided that they have the necessary experience and training, external facilitators have the advantage that they attend the meeting with an objective perspective. The external facilitator can be someone from the Quality department (von Zedtwitz, 2002). In the case this means someone from the department Knowledge Management that is also responsible for quality assurance. However, the Knowledge Management is also responsible for the granting of governmental funding and thus, the internal customer of knowledge-creating projects. Furthermore, the success of the session is also dependent on the motivation and support of all involved. This support is likely to be higher if the session will be seen as a procedure required by their own department, rather than a staff department.

From the own department, the project manager can be the facilitator of the meeting but the disadvantage is that he is not objective at all. Most suitable of all is the technology manager. He has certain objectivity and he’s from the own department. Furthermore, as there is only one technology manager for every department and only seven functional departments, there are only seven technology managers. This means that they can be trained to facilitate future post-project reviews within their department.

4.5 Items on the agenda of the session

<table>
<thead>
<tr>
<th>What went good or wrong?</th>
<th>Why?</th>
<th>How could we have done it differently?</th>
<th>What can we learn from this for future projects?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did we reach are goals/deliverables? Are our (internal) customers satisfied?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How did the process go? (planning/actions/allocation of tasks/communication)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How did deal with risks?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did we stay within the budget?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As the session has multiple independent goals, the sessions are split up according to these goals. It’s easiest to start with the goal of organisational learning as this is looking back to the whole execution of the project. For this first part a number of questions (figure 4) are formulated which are derived from the current project review form.

The second part of the session, the discussion about application and commercialisation of the projects’ deliverables starts with the reached deliverables of the project. This is already made clear during the first part of the session. The questions of figure 5 are formulated for this part of the session.

Finally, the session itself will be reviewed for continuously improving the session itself.

The assessment of the projects will be done after the session. This will cause as little as possible disturbance to the free discussion.

4.4 Preparation and follow-up of the session

In order to achieve the session objectives, it is important that the persons involves will prepare the session beforehand and that actions agreed will be followed up afterwards. The preparation requirements for all people involved are different. The project manager must have all the necessary information (process information, project report) available and distributed to the other participants. Next to that, the manager is the one initiating the session. The technology manager must make sure everything happens in time.

The follow-up is market oriented and therefore it is the responsibility of the sales manager. During the session an action list with the steps that must be taken will be drafted: the sales manager is responsible for these steps.

Figure 4: Questions review
5. Pilot sessions

Before permanent implementation of the pilot-sessions, ten pilot-sessions were organised. The pilot-sessions should give more insight and understanding of the process and based on the results, adjustments could be made. It was also an opportunity to confront the employees with the concept before becoming a standard organisational process. Furthermore, based on the results of the pilot-sessions the management team can decide whether to continue or not.

5.1 Execution

To make possible to carry out the pilot sessions in short term, some changes were to the previously described design. Most importantly is that Knowledge Management initiated and facilitated the sessions, because the technology managers are not trained yet in chairing the sessions. Knowledge Management cooperated in developing the sessions and had full knowledge of details and reasoning.

The projects that were selected for the pilot sessions were from the different functional departments. Nine out of ten projects were fully funded by the government grants, one project was funded for 25% by a commercial organisation. All projects were completed; it was known that some projects would be followed-up by a subsequent project.

For all projects a meeting was organised with the participation of the project manager, the technology manager, the sales manager and a representative of Knowledge Management. The project manager was encouraged to invite key players of the project team as well. In one department, the department manager carries out the role of sales manager and technology manager. Therefore, only three people were present at those sessions.

To evaluate the pilot-sessions, these were observed and the participants were asked for their opinion. The focus of both the observations and the questionnaire was on the extent the objectives of the session were met and if not what were the possible reasons for that.

After two sessions was already clear that a single session for both the project review and the knowledge application discussion is ineffective. The main reason for this was a defensive attitude of the project manager after the first part of the session, reflection for organisational learning. The defensive attitude seems to stem from the project assessment part and the facilitation by the board member responsible for technology (representative of the department Knowledge Management). The fact that it was the first confrontation with the post-project review might have had some influence as well.

As defensive attitude it is not desirable, from the third pilot-session on; the sessions are strongly focus on discussing the knowledge application and less focused on a project review. The project review was reduced to one question at the end of the meeting: Hence, the session is called ‘Knowledge application discussion’.

5.2 Results

As mentioned, the results were determined by observation and feedback from the participants.

Observation indicated a lot of variation...
between different sessions. Various aspects caused the differences. One of these aspects was the nature of the project; some projects are more fundamental, others more applied (figure 6). This resulted in different discussions during the sessions. Discussions during sessions of more fundamental projects were focussed on possibilities of application of the results. These projects in general already had a follow-up project and although funding for the follow-up project was granted, the application and commercialisation of the projects’ outcomes wasn’t considered. This resulted during the sessions in a discussion for direction of the follow-up project. The session added value to the process because the question about the application and commercialisation of the results were brought up and the researchers were forced to think about it. An example of a concrete deliverable of the sessions was an appointment for further development of the roadmap.

Discussions during sessions of more applied projects involved the commercialisation of the created knowledge, the application of the knowledge was already known. The added value of the session was originating form the new insights of the ‘outsiders’ and by the stimulation to explore all commercial possibilities. Concrete deliverables of these sessions was e.g. a to-do-list with actions like the approach of specified organisations by the sales manager.

The atmosphere was another aspect that made a difference between the sessions. A good atmosphere proved vital to reach the goals of the sessions, during two sessions, participants felt not very motivated. Both sessions had no designated deliverables, all others had.

<table>
<thead>
<tr>
<th>Question / Thesis</th>
<th>Agree</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think the session was useful?</td>
<td>94%</td>
<td>6%</td>
</tr>
<tr>
<td>'Discussions about knowledge application will contribute to a conscious evaluation of the innovation process'</td>
<td>93%</td>
<td>7%</td>
</tr>
<tr>
<td>'Discussions about knowledge application will improve the number of project results that are commercialised afterwards'</td>
<td>71%</td>
<td>29%</td>
</tr>
<tr>
<td>'Project reviews will improve organisational learning'</td>
<td>80%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Figure 7: Summary results questionnaire pilot-sessions

5.3 Final design post-project market review

After the pilot-sessions, the management was advised to continue the sessions (knowledge application discussion) and they agreed to this for all projects with 100% governmental funding. The sessions would be held in the same form as the pilot-sessions with some minor improvements. Furthermore, the sessions would eventually be facilitated by the technology managers of the departments and be initiated by the project manager. The introduction of the session as a standard procedure would be done gradually. Important point of attention is the motivation of the participants of the sessions. All technology managers should be convinced of the usefulness and this must be communicated thoroughly to all other participants.

6. Conclusions & Discussion

In this case study, the concept of post-project review is used as a tool to stimulate the commercialisation of new technologies. The essence of the knowledge-application discussion is to bring multi-functional and multilevel participants together at the end of a knowledge-creating project to discuss the application and commercialisation of the project results. For projects followed up by a new (wholly or partly governmental funded) project, the knowledge application discussion resulted in a framework for the direction of the next project; hence, a post-project review session - before the follow-up project begins - can become a stimulant of the innovation process. In this sense the session can be seen useful and 71% said that they thought that the sessions in general would improve the number of projects that will be commercialised (figure 7).
as a moment of reflection on the direction taken with regard to future market opportunities. During the innovation process, the discussion will develop from a discussion about the application itself to the commercialisation of it.

By involving the technology managers and Knowledge Management, the sessions are becoming also tools to relate projects or innovation processes (groups of projects) to each other and widen their scope: the knowledge-creating projects are this way not limited to a single discipline in the chain from fundamental to applied knowledge, but can expand across disciplines and research areas.

Next to the session, it is also necessary to reflect on the value of the innovation at the beginning of the innovation process; a suitable moment for reflection is the submission of request for government funding; the request must be also be based on future market opportunities. In this case this means changing the current attitude towards the granting procedures and criteria so that the organization is able follow the line of increasing the chances to focus on commercially interesting projects. This will require, among other things, a more extensive market exploration.

For further research the next questions will be interesting:

- How common are knowledge-application discussion sessions in organisations and how are they carried out with regard to objectives, participants, facilitation, and items on the agenda?
- During the pilot sessions, the combination of reviewing and discussing the application didn’t seem to work; should this be two, separated discussion items?
- Furthermore, what other tools are used to tackle the lack of commercialisation of governmental funded projects?

References


Projects last for the time they are granted financing, in generally, one year. After that year, a new project can be started to continue the subject. In this way, a set of successive projects can develop from idea to application. The commercialisation occurs in projects as well.

1
LIQUIDITY CONSTRAINTS UPON START-UPS WITH NEW PRODUCTS: A STUDY OF REASONS FOR FAILING TO ACCESS FINANCE USING GLOBAL ENTREPRENEURSHIP MONITOR (GEM, 2005) UK DATA

By

Brooksbank, D. J. Jones-Evans, D. Kwong, C. C. Y. Thompson, P. and

Ullah, F.*

National Entrepreneurship Observatory of Wales (NEO)

Business School

The University of Glamorgan

Treforest, Pontypridd,

CF37 1DL

United Kingdom

E-mail: fullah@glam.ac.uk

Tel: + 44 (0)1443 483 370

Fax: + 44 (0)1443 483 650

* Corresponding author

*Although data used in this work are collected by the GEM consortium, their analysis and interpretation are the sole responsibility of the authors.

Abstract
The possibility of differing reasons for finding finance between innovative and non-innovative start-ups is examined using data from the Global Entrepreneurship Monitor (GEM) for the UK. A sample of 140 start-ups who reported they had problems in accessing one or more sources of funding was subdivided into start-ups intending to produce new products, and those producing established products. The sources of finance used by, and refused access to, by these groups of start-ups were examined, along with the reasons for failing to access sources of funding. It appears that those attempting to provide a new good or service often rush in without full preparation, more often suggesting that the reason for failing to access finance was due to not being investor ready and having inadequacies in the business plan than those intending to sell established products. The implication being that in order to encourage innovation it is necessary for policy makers to ensure that innovative entrepreneurs are provided with the business skills required to ensure that their ideas make it to the market place, rather than being aborted due to a lack of finance.

Keywords: Innovation, start-up, finance, Venture Capital, Business Angels, Entrepreneurs

1. Introduction
The importance of small and medium sized enterprises (SMEs) and particularly the Technology-based small firms (TBSFs) has been increasingly recognised in replacing the old industrial base of the UK and other industrial economies of the world. The UK which was once known as the workshop of Europe has been going through a major creative destruction and economic reshuffle in the past forty years. Consequently, this economic restructuring and renewal has resulted into the emergence of unprecedented new and novel business ideas. As a result we have seen a major upsurge in the creation of SMEs and TBSFs in the UK and elsewhere. They are the source of most new jobs and make significant contributions to innovation and high technology employment. They are also crucial for regional development and social integration. Nevertheless, less than one-half of small firm start-ups survive for more than five years, and only a fraction develop into high performance firms (OECD, 2000). Whereas large firms may find finance relatively easier to come by, it is the SMEs who are faced with the greater financing constraints, that are the firms free of the organisational rigidities associated with larger firms, which thwart innovation (Tourigny and Le, 2004). Financiers such as banks, venture capitalists and business angels justify their risk-averse behaviour by the higher failure rates among small firms.

In spite of this confusion and misunderstanding among the small business starters and existing owners, the UK central and regional governments, financiers and development agencies are attempting to overcome the funding gap. This public interest in small firms funding gap is not a recent phenomenon. Bolton (1971) and Wilson (1979) presented their reports on finance for small firms. Bolton (1971) reported that there was no institutional deficiency in the financial markets for small firms in the UK and hence did not justify government intervention in the finance markets for small firms.

The Wilson (1979) report did not find any evidence that suggested a general shortage of finance for small firms in the UK but suggested that some small start-up firms might experience problems in raising amounts of up to £10,000 and small development firms may find it difficult to raise finance in the range of £15,000 to £150,000. All these public enquiries took a holistic approach rather than focusing in more detail on a particular group of the SMEs population. The first public enquiry that is of direct relevance to the financing of innovative
high growth firms in the UK is that of the Advisory Council on Science and Technology (ACOST) in 1990. This enquiry focused on TBSFs finance and the financial constraints that these firms encounter at earlier critical stages of development. Due to the higher risk associated with TBSFs and difficulties of assessing technology and innovativeness, this enquiry found that institutional investors particularly banks, were hesitant to provide financial assistance. In this paper we are concerned specifically with the financing environment for small innovative entrepreneurs who are either (a) introducing a completely or partially new product (b) process innovation with new production technologies being used.

In either case it is envisaged that entrepreneurs with new business ideas encounter many problems particularly in raising finance at the earlier stages of their business development. Literature review in section 2 suggests that these funding problems are more acute if the new product or service is based on an innovative idea emanating from academic or scientific research undertaken in the universities or other research organisations.

2. Literature overview
In its simplest form the term innovation means that those entrepreneurs/firms which introduce a new idea into the marketplace in the form of a new product or service or an improvement of an organization or process are called innovative entrepreneurs/firms. Koberg, Uhlenbruck and Sarason (1996) suggest that small firms due to their informal structure are more innovative than the large firms with formal and mature structure. In this context our sample firms have either introduced completely new products/service or alternatively made use of new production technology.

The development of innovative products/services is often constrained by the lack of finance, particularly in the case of growing technology-based small firms (Pissarides, 1999; Harrison and Mason, 2004). The majority of small firms finance usually comes from family sources (Bates, 1997), but the traditional sources of finance from family and friends, business angels and banks are often inadequate to fund the new innovative products at the early stages of business development. Although small firms have the comparative advantage of dynamism and flexibility than large firms, they are constrained in securing funds for the growth of their innovative products/services. This is more acute for TBSFs than the conventional SMEs, which generally stay small. High growth firms need to grow in order to respond to the changing environment around them. This involves developing new innovative products and diversifying the existing ones to follow the market trends, and it is these processes that may be hindered by the lack of finance at early stages of business development.

Consensus suggests that access to appropriate finance at the appropriate time (particularly at the earlier stages) of business development is considered as a key element in the successful development of a new business idea. This is specifically true if the firm is operating in the high technology sectors (Westhead and Storey, 1997).

Although other arguments that have been put forward one of the main explanations for small firms funding gap is that there exists an agency conflict, where the entrepreneurs and financiers interact, but with conflicting interests (Jensen and Meckling, 1976; Myers and Majluf, 1984; Amit, Glosten and Muller (1990); Chan, Seigel and Thakor, 1990; Admati and Pfleiderer, 1994; Cable and Shane, 1997; Bergemann and Hedge, 1998; Hart and Moore, 1998). To explain this situation, Admati and Pfleiderer (1994), and Hart and Moore (1998) outline an ideal financial contracting problem which involves an entrepreneur with an idea, but lacking capital to put the idea into practice. Admati and Pfleiderer (1994) also assume that the project goes through certain stages of development, and at each stage the project should be assessed, and decisions made on whether the project is feasible enough to go ahead, or should be abandoned. If the project is viable and is continued, the additional amount of capital required must also be determined. It is also assumed that at each stage the
entrepreneur observes private information about the profitability of the project and that this information is not observed by outside investors and therefore cannot be observed at the outset. This asymmetry of information between entrepreneurs and the finance providers consequently give rise to other aspects of financing problems such as moral hazard and adverse selection. Empirical studies including; Himmelberg and Petersen (1994), Berger and Udell (1998), Wright and Robbie (1998), Jordan, Lowe and Taylor (1998) confirm that informational asymmetry is the most important factor in constraining small business finance, and this is more acute in the case of TBSFs.

Closing this information gap is difficult given the cost of information relating to small firms, which means the information gap and resultant funding gap remain (Stiglitz and Weiss, 1981). Jensen and Meckling (1976) suggest that it is generally impossible to expect entrepreneurs to be honest at zero cost. Although the involvement of external financiers within a firm such as venture capital firms (VCs) will make accessing additional funds easier as the level of moral hazard from the agency problem is reduced (Dewatripont and Tirole, 1994), as such venture capital financing is one of the most important sources of finance for technology-based start-ups particularly in the US (Bergemann and Hedge, 1998). Cable and Shane (1997) suggest that greater co-operation between entrepreneurs and VCs is indespensible for successful business growth.

The small firms finance problems is not just due to the shortage of funds. Governments in many countries are quite often trying to increase the supply of funds, but it is suggested that in addition to the supply-side financial constraints there are demand-side financial constraints (Cressey and Oloffson, 1997). A supply-side financial constraint constitutes a capital market imperfection that leads to a socially incorrect supply of funds to projects, or an incorrect interest rate charged on funds. On the other hand a demand-side financial constraint is a capital market imperfection in which the performance of a firm is adversely affected by a factor internal to the firm. For example if a firm’s owner wants to grow the firm but the only way to grow is to relinquish equity and he/she do not wish to do so. In such a situation they suggest the firm is finance constrained due to demand-side factors.

In terms of what is the most appropriate source of finance for SMEs and in particular TBSFs, Berger and Udell (1998) suggest that in a firm’s life cycle different financial structures are optimal at different points, so that capital structures change with firm size and age. Private markets tend to provide finance to informationally opaque small businesses, while public markets fund businesses which are large and more transparent. Berger and Udell (1998), suggest that financial intermediaries, such as VCs, play an important role in screening, contracting with, and monitoring small businesses, which helps reduce information opacity. VCs collect information about the business, potential markets, collateral, and the management team of small businesses. Small businesses remain informationally opaque even after some experience is gained as compared to large firms because their activities are largely invisible. TBSFs which carry high risk but exhibit high growth quite often receive external equity (venture finance) while those which are low risk and low growth, in other words, conventional SMEs, more often obtain external debt (bank finance). Venture finance becomes available in most cases after firms receive one or two rounds of angel finance while bank finance often comes after firms assets becomes more tangible and could be offered as collateral (Berger and Udell, 1998). Berger and Udell (1998) suggest that moral hazard problems occur when larger amounts of external finance are needed relative to internal finance. To keep control of the business, entrepreneurs may choose external debt and to share risk they may choose external equity. Himmelberg and Petersen (1994) suggest there is a ‘pecking order’ regarding the most sought after sources of finance.

According to Pecking Order Hypothesis (POH) firms exhaust internal sources first (personal savings, family and friends and retained earnings) followed by debt finance
(usually from banks) and finally equity or risk capital (Venture Capital finance). However, this pattern does not hold true for TBSFs, as studies of TBSFs find a greater preference for equity finance, and little desire for debt finance, due to a mix of greater perceived informational asymmetries on the part of banks, than equity investors, and because of different motivations of owners (Roberts, 1991; Hogan and Hutson, 2005). For innovative products, or new ideas, which are typically characterised by information opacity, VC finance is considered to be the most appropriate (Gompers, 1995; Wright and Robbie, 1998). However, Landstrom (1993) suggests that this ideal source of finance seems to be short in many countries. MacMillan, Siegel and Narasimha (1985) and Muzyka, Birley and Leleux (1996) discuss the use of different criteria by VCs to select projects for financing. MacMillan, Siegel and Narasimha (1985) find from a survey of 100 VCs that the most frequently used criterion is the quality of the entrepreneur, with five of the top ten most important criteria relating to the entrepreneur’s experience and personality. They question why there is so much emphasis on the business plan by VCs as a business plan hardly reflects the characteristics of an entrepreneur. Muzyka, Birley and Leleux (1996) find that VCs prefer to select an opportunity that includes a good management team, reasonable financial and product-market characteristics.

Previous studies show that it appears that the greatest constraint on the supply side of the financing of SMEs is the informational asymmetry that exists between the financier and the entrepreneur. This problem is greater when the product in question is new and unproven and therefore it would be expected that the firms within this study attempting to sell completely new products, will have greater difficulty in convincing external sources of finance of the merits of their start-ups’ opportunities. On the demand side firms constrain themselves by appearing to be unwilling to access debt financing, which would suggest that those firms with innovative products in our sample will show a preference for equity finance either from venture capital firms or business angels.

3. Data and Research Methodology

This paper examines the reasons that nascent entrepreneurs identify for failing to access funding comparing those introducing new products into the market with those who attempt to provide established goods and services. The data used in this study is from the GEM (2005) survey for the UK which was collected through telephone interviews during spring and early summer of 2005 using a standardised questionnaire. It is a large sample with a total of 31,649 randomly selected individuals being questioned on their involvement or lack of involvement in enterprise activities. This sample includes a total of 602 nascent entrepreneurs (individuals actively involved in a business start-up which has not paid wages or made profits for three or more consecutive months). Of these nascent entrepreneurs 140 start-ups who had reported that they had previously had problems in accessing one or more sources of funding were identified and are used in this study. In order to provide a simple indication of whether start-ups are providing an innovative drive to the economy, respondents were asked whether they intended to sell new or existing products to the market and how long the production technology they intended to use had been available for. From the sample 20 start-ups suggested they will provide a good or service completely new to their customers (innovative product) and 46 will provide goods or services that are new to some of their customers (partially new product). The sample was also classified according to whether the start-ups intended to use production technology that had been available for (a) less than one year (new technology), (b) between one and five years (partially new technology) and (c) more than five years (existing technology).

The nascent entrepreneurs were asked in the GEM survey a number of questions relating to the types of finance they have utilised but also those that they had attempted to
access but failed. Data for successful (the ‘seek-and-succeed’ rate) and unsuccessful attempts (the ‘seek-and-fail’ rate) made on each type of external finance source is available in the GEM UK dataset. Two extra variables are calculated for this study. They are (a) the attempt rate and (b) the rejection rate. The attempt rate is the number of firms attempting to use each source of finance calculated by adding the rates of successful and unsuccessful attempts in gaining finance minus double counting. The rejection rate is simply the percentage of attempts which are unsuccessful. In addition, reason for failure to access finance is also recorded if available.

4. Characteristics of Innovative Entrepreneurs

New and existing product entrepreneurs have distinctively different motives for starting businesses (Table 1). When compared to existing product entrepreneurs innovative product and partially new product entrepreneurs are more likely to start a business due to the challenge of leading their own businesses (71% for new, 77% for partially new and 64% for old) and to pursue an idea innovation or hobby (61.3% for new, 65.2% for partially new and 47.2% for old). This corroborates Hogan and Hutson (2005) who finds that the main motivation for TBSF start-ups is to introduce new ideas about products or services. Innovative product entrepreneurs are also less likely to start their business due to dissatisfaction in their previous job (16% for new and 27% for old). This suggests that innovative product entrepreneurs are passionately attracted to entrepreneurship rather than being pushed into it by necessity.

Table 1 Motivation for starting a business by product innovation*

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Innovative</th>
<th>Partially new</th>
<th>Existing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The challenge of leading own business</td>
<td>Number</td>
<td>44</td>
<td>104</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>71.0</td>
<td>77.0</td>
<td>63.9</td>
</tr>
<tr>
<td>To pursue an idea, innovation or hobby</td>
<td>Number</td>
<td>38</td>
<td>88</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>61.3</td>
<td>65.2</td>
<td>47.2</td>
</tr>
<tr>
<td>Dissatisfied in current job</td>
<td>Number</td>
<td>10</td>
<td>38</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>15.9</td>
<td>28.1</td>
<td>26.9</td>
</tr>
<tr>
<td>Have difficulty finding paid employment</td>
<td>Number</td>
<td>4</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>6.3</td>
<td>9.6</td>
<td>6.7</td>
</tr>
<tr>
<td>None of these</td>
<td>Number</td>
<td>3</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>4.8</td>
<td>5.2</td>
<td>12.6</td>
</tr>
</tbody>
</table>

* Respondents are allowed to select more than one motivation, and therefore percentages do not sum to one hundred.

As innovative product entrepreneurs are often drawn into entrepreneurship as a result of inspiration rather than necessity, they are usually more ambitious than existing product entrepreneurs. Innovative product entrepreneurs tend to require a larger amount of start up funds when compared with partially new product and existing product entrepreneurs. The median average funds required for starting-up a business is £20,000 for innovative product, £13,000 for partially new product and £10,000 for existing product. However, the average median amount of investment that innovative product entrepreneurs invested personally was only £10,000, which means that 50% of the funds required for the business start-up needs to be acquired externally. On the other hand the average median of personal start-up investment for existing product entrepreneurs is £9,300. Although this is marginally smaller than the amount innovative product entrepreneurs invested, this covered 93% of the total funds required to start a business. Thus the funding gap for existing product entrepreneurs is arguably smaller.

Innovative product entrepreneurs also have high expectations. The average median innovative product entrepreneur expects his/her annual turnover to rise from £60,000 to
£250,000 within three years. This represents an increase of 138% per annum. In contrary the average existing product entrepreneur only expects their annual turnover to rise from £45,000 to £75,000, representing an increase of just 20% per annum.

Such optimistic expectation of future prospect may or may not be justifiable. However, it is hard for assessors to know this as there is no precedent to follow. When such expectation is incorporated into the business plan, banks and other financial investors are likely to question such high expectations of return.

Table 2 Mean and median characteristics of the sample by product innovation

<table>
<thead>
<tr>
<th></th>
<th>Innovative</th>
<th>Partially new</th>
<th>Existing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start up funds required (£)</td>
<td>101,256</td>
<td>71,293</td>
<td>85,588</td>
<td>83,683</td>
</tr>
<tr>
<td></td>
<td>(20,000)</td>
<td>(13,000)</td>
<td>(10,000)</td>
<td>(13,000)</td>
</tr>
<tr>
<td>Start up funds required from external sources (£)</td>
<td>39,148</td>
<td>16,375</td>
<td>33,169</td>
<td>29,167</td>
</tr>
<tr>
<td></td>
<td>(10,000)</td>
<td>(7,500)</td>
<td>(9,300)</td>
<td>(9,057)</td>
</tr>
<tr>
<td>Estimated annual turnover (£)</td>
<td>391,940</td>
<td>1,060,340</td>
<td>272,945</td>
<td>526,427</td>
</tr>
<tr>
<td></td>
<td>(60,000)</td>
<td>(50,000)</td>
<td>(45,000)</td>
<td>(50,000)</td>
</tr>
<tr>
<td>Estimated annual turnover in three years' time</td>
<td>1,071,259</td>
<td>2,108,955</td>
<td>2,043,521</td>
<td>1,889,408</td>
</tr>
<tr>
<td></td>
<td>(250,000)</td>
<td>(80,000)</td>
<td>(75,000)</td>
<td>(98,500)</td>
</tr>
<tr>
<td>Current employees</td>
<td>9.9</td>
<td>66.9</td>
<td>17.5</td>
<td>35.6</td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td>(3)</td>
<td>(0)</td>
<td>(1)</td>
</tr>
<tr>
<td>Expected employees in 5 years time</td>
<td>28.4</td>
<td>23.8</td>
<td>14.6</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
<td>(6)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
</tbody>
</table>

* Median characteristic values shown in parenthesis

Table 3 suggests that there is indeed a funding problem for innovative product entrepreneurs. Only 31.6% of innovative product entrepreneurs feel that there are adequate external funding compared to 33.3% for partially new product entrepreneurs and 40.5% for existing product entrepreneurs.

Table 3 Whether respondents feel that there is lack of external funding available by product innovation

<table>
<thead>
<tr>
<th></th>
<th>Innovative</th>
<th>Partially new</th>
<th>Existing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>12</td>
<td>24</td>
<td>34</td>
<td>70</td>
</tr>
<tr>
<td>%</td>
<td>63.16</td>
<td>53.33</td>
<td>45.95</td>
<td>50.72</td>
</tr>
</tbody>
</table>

5. Financing channels of innovative entrepreneurs

The rest of this study looks at the liquidity problem more closely by breaking down external finance into smaller categories, then examining each source of finance entrepreneurs attempted to obtain, both successfully and unsuccessfully. Data for successful and unsuccessful attempts made on each type of external finance source is available in the GEM UK dataset. Two extra variables are calculated for this study. They are, the attempt rate (Table 4), and the rejection rate (Table 5).
Table 4 Attempted source of finance by respondents by product innovation

<table>
<thead>
<tr>
<th>Source of Finance</th>
<th>Innovative</th>
<th>Partially New</th>
<th>Existing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friends and Family</td>
<td>32</td>
<td>77</td>
<td>146</td>
<td>255</td>
</tr>
<tr>
<td>%</td>
<td>25.4</td>
<td>32.1</td>
<td>35.3</td>
<td>32.7</td>
</tr>
<tr>
<td>Business Angels</td>
<td>26</td>
<td>51</td>
<td>56</td>
<td>133</td>
</tr>
<tr>
<td>%</td>
<td>20.6</td>
<td>21.3</td>
<td>13.5</td>
<td>17.1</td>
</tr>
<tr>
<td>Unsecured Bank Loan</td>
<td>15</td>
<td>24</td>
<td>77</td>
<td>116</td>
</tr>
<tr>
<td>%</td>
<td>12.0</td>
<td>10.0</td>
<td>18.6</td>
<td>14.9</td>
</tr>
<tr>
<td>Bank Overdraft</td>
<td>18</td>
<td>52</td>
<td>120</td>
<td>190</td>
</tr>
<tr>
<td>%</td>
<td>14.3</td>
<td>21.7</td>
<td>29.0</td>
<td>24.4</td>
</tr>
<tr>
<td>Non-Bank Unsecured Loan</td>
<td>5</td>
<td>35</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>%</td>
<td>4.0</td>
<td>14.6</td>
<td>4.8</td>
<td>7.7</td>
</tr>
<tr>
<td>Mortgage</td>
<td>6</td>
<td>26</td>
<td>62</td>
<td>94</td>
</tr>
<tr>
<td>%</td>
<td>4.8</td>
<td>10.8</td>
<td>15.0</td>
<td>12.1</td>
</tr>
<tr>
<td>Venture Capital</td>
<td>12</td>
<td>21</td>
<td>23</td>
<td>56</td>
</tr>
<tr>
<td>%</td>
<td>9.5</td>
<td>8.8</td>
<td>5.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Government Grants</td>
<td>21</td>
<td>56</td>
<td>49</td>
<td>126</td>
</tr>
<tr>
<td>%</td>
<td>16.7</td>
<td>23.3</td>
<td>11.8</td>
<td>16.2</td>
</tr>
<tr>
<td>Credit Cards</td>
<td>24</td>
<td>37</td>
<td>56</td>
<td>117</td>
</tr>
<tr>
<td>%</td>
<td>19.0</td>
<td>15.5</td>
<td>13.5</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Table 5 Rejection rate by product innovation

<table>
<thead>
<tr>
<th>Source of Finance</th>
<th>Innovative</th>
<th>Partially New</th>
<th>Existing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>8.2</td>
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<td>36</td>
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<td>29.2</td>
<td>33.8</td>
<td>30.8</td>
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<tr>
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<td>30</td>
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<td>15.8</td>
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<td>19</td>
</tr>
<tr>
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<td>45.0</td>
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<td>33</td>
</tr>
<tr>
<td>%</td>
<td>66.7</td>
<td>32.0</td>
<td>33.9</td>
<td>35.5</td>
</tr>
<tr>
<td>Venture Capital</td>
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<td>18</td>
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<td>25.0</td>
<td>32.1</td>
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<tr>
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<td>42</td>
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<td>%</td>
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<td>38.8</td>
<td>33.3</td>
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<td>Credit Cards</td>
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<td>20</td>
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<td>16.4</td>
<td>17.2</td>
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</table>

(i) Friends and Family
Table 3 shows that friends and family is the most popular source of finance sought after by innovative product entrepreneurs as would be expected following the POH where internal sources of funding are utilised before looking for external sources of finance (Myers, 1984; Myers and Majluf, 1984). However, when compared with other types of entrepreneurs the attempt rate for friends and family loan is much lower from innovative product entrepreneurs (25.4%) than from partially new product (32%) and existing product (35%) entrepreneurs. In addition innovative product entrepreneurs also have the highest rejection rate of all types of entrepreneurs using this channel of finance. The rejection rate is 26% for innovative product entrepreneurs which is much higher than that of partially new product (8%) and existing product (8%) entrepreneurs. Although there may be a self-selection problem, these data largely indicate that it is generally more difficult for innovative product entrepreneurs to obtain finance from their friends and family than by entrepreneurs using older products. This indicates that innovative product entrepreneurs have difficulties to convince their friends and family that their product will be a sell-out. This is mainly due to the problem of lack of information. It is most likely that their friends and family had never heard of their product. As
there is no precedent regarding the product, it is also very difficult for them to make a prediction on the likely reaction from the market and the demand for the product. This is not helped by the fact that friends and family do not normally ask for a formal business proposal which make it even more difficult for them to make a rational decision regarding their investment behaviour.

On the other hand the *seek-and-succeed* rate for *partially new product* entrepreneurs from *friends and family* is very similar to the rate for *existing product* entrepreneurs (32% compared to 34%). In addition both types of entrepreneurs have much lower rejection rate than *innovative product* entrepreneurs. This indicates that friends and family are almost indifferent between lending to *partially new product* and *existing product* entrepreneurs. In fact a *partially new product* is most likely to be an *in product* that is proven to be a market success. There may possibly be a large amount of media coverage surrounded the product due to aggressive advertisement strategy promoted by some pioneer companies. Thus there are more knowledge and facts for *friends and family* investors to base their decision on. In addition the fact that it is a new product may possibly create a *thrill* effect that may well reduce the level of rejection. In other words *friends and family* investors do not mind a product being exotic as long as it is not too exotic. Data also indicates that *friends and family* are often treated as the last resort for funds as 38% who reported to have unsuccessfully obtained finance from *friends and family* also have successfully obtained finance from *friends and family*, in other words multiple attempts are often made upon this source of finance.

(ii) *Equity Finance*

*Business angels* are the second most popular source of finance sought after by *innovative product* entrepreneurs with 20.6% of respondents reported to have sought finance from this channel. *Venture capital* receives less attention from *innovative product* entrepreneurs with 9.5% of respondents attempted to seek finance through it. However, the attempt rates for both *business angel* and *venture capital* are higher from *innovative product* than *existing product* entrepreneurs (13.5% for *business angel* and 5.6% for *venture capital*) suggesting that equity finance is relatively more popular amongst *innovative product* entrepreneurs as had been found by previous studies. This is possibly due to the fact that TBSF owners feel venture capitalists understand their businesses better than banks (Gompers and Lerner, 2003; Hogan and Hutson, 2005) or specialise in certain fields (Dahlstrand and Cetindamar, 2000). Preconceptions such as these could explain the higher attempt rates by *innovative product* entrepreneurs particularly as it has been shown that TBSF owners are more willing to give up control in order to pursue greater innovation (Berggren et al., 2000) or greater growth to achieve financial reward on exit (Cressey and Olofsson, 1997). Although it is true that equity financiers are likely to be less risk averse than debt financiers as they share in upside in the business but this does not by any means suggest that they are reckless in making business decisions. As a matter of fact the rejection rates by both *venture capital* and *business angels* are much higher for *innovative product* than for *existing product* entrepreneurs (58.3% compared to 26% and 42.3% compared to 37.5% respectively). This suggests that poor business ideas with inadequate planning are still likely to be rejected by equity financiers.

(iii) *Bank and other financial loans*

The attempted usage of banking and other related financial products is low amongst *innovative product* entrepreneurs with the attempt rates being 12% for unsecured bank loan, 5% for secured bank loan and 4% for non-bank unsecured loan (the respective rates for *existing product* entrepreneurs are 18.6%, 4.8% and 15%). Consequently, the *seek-and-succeed* rate for bank and other financial loans is relatively low amongst *innovative product*
entrepreneurs ranging from 3.2% for non-bank unsecured loan to 11% for unsecured bank loan. The seek-and-succeed rates for innovative product entrepreneurs are much lower than that of existing product entrepreneurs and in the case of mortgage and non-bank secured loan also lower than partially new products, confirming the findings of Hogan and Hutson (2005). Innovative product entrepreneurs also have the highest rejection rate of all types of entrepreneurs using mortgage and non-bank unsecured loan at 67% and 40% respectively. For mortgage the rejection rate is twice as high as partially new products and old products entrepreneurs.

These figures indicate that debt finance is not popular amongst innovative product entrepreneurs and there is a high rejection rate for those who choose to use this method of finance. The self-exclusion with this method of finance is likely to be due to entrepreneurs’ perception of the low likelihood of success due in part to the intangible nature of much of the new product entrepreneurs’ assets (Myers, 1977; Hogan and Hutson, 2005). Bank lending is often based on formal business assessment. However, constructing a business plan for new product is highly difficult. Market reaction and demand for new product is simply impossible to predict which makes the self-assessment of innovative product entrepreneurs hard to validate. Thus lending to innovative product entrepreneurs can be a very risky business for banks and financial institutions even if the idea seems likely to succeed particularly as debt financiers would not share in any upside.

Banks are found to be more likely to cater for partially new product entrepreneurs. When the product is new to some but not to everyone it is found that bank seek and succeed rates for bank-related sources are higher than average while the rejection rates are lower than average. This is because bank assessors are likely to have heard of a partially new product due to their job nature and therefore are able to assess the potential of the product. Bank lending is also found to be keener on partially new products over existing product both in terms of lower rejection rates. This is because partially new products have potential to expand while a market for an old product is often saturated.

(iv) Government Grants
According to the figures government grant is most sought after by partially new product entrepreneurs (23.3%) followed by innovative product entrepreneurs (17%) and existing product entrepreneurs (12%). However, when it comes to rejection rate it is the innovative product entrepreneurs who suffered with 48% of funding requested being rejected. This is by far the largest rejection rate with existing product entrepreneurs being a remote second at 39%. The partially new product entrepreneurs on the other hand have the lowest rejection rate at 23.2%. The finding indicates that like banks and other formal financial institutions, government grants have the reputation of lending largely to partially new products entrepreneurs rather than the brand new product entrepreneurs. Thus although the government often tries to promote innovative enterprise development, they prefer to assist proven innovations that are already tested by the public. To support a new innovation is probably too risky for the government and can lead to political backlash when attacked by the public.

(v) Short-term Debt Financing
Although it may come as a surprise, many entrepreneurs have used credit cards and overdraft to fund their business venture. 19% of innovative product entrepreneurs have attempted to use credit card while 14% have used overdraft. These informal loans are more popular than other bank loans due to the relatively less formal application procedures (relatively hassle free) and relatively low rejection rates. The rejection rates for overdraft and credit card are
17% and 25% respectively which are amongst the lowest of all financial sources. They are therefore, often used by entrepreneurs as a last resort when all other methods failed.

6. Financing channels of new technology entrepreneurs
This study also looks at the financing channels of new technology entrepreneurs. Although the overall picture is less clear, the high usage of friends and family and short term debt finance and the low usage of formal financial channels suggest that new technology products may find it even more difficult to finance their product through external sources. Friends and family is the most popular source of finance sought after by new technology entrepreneurs with 39.4% of respondents reported to have used finance from these channels. Bank overdraft and credit card come remote second and third with 17.4% and 15% of respondents respectively reported to have used these informal channels. Formal financial channels appear to be less popular with new technology entrepreneurs, with none of the usage rate exceeds 15% from new technology entrepreneur respondents.

| Table 6 Attempted source of finance by respondents by production innovation |
|----------------------------------------|--------|--------|--------|--------|
|                                       | <1 Year| 1-5 Years | 5+ Years | Total  |
| Friends and Family                     | No     | 43   | 53   | 159   | 255   |
|                                       | %      | 39.4 | 31.9 | 31.5  | 32.7  |
| Business Angels                        | No     | 8    | 40   | 85    | 133   |
|                                       | %      | 7.4  | 24.1 | 16.8  | 17.1  |
| Unsecured Bank Loan                    | No     | 14   | 33   | 69    | 116   |
|                                       | %      | 12.8 | 20.0 | 13.7  | 14.9  |
| Bank Overdraft                         | No     | 19   | 57   | 113   | 189   |
|                                       | %      | 17.4 | 34.3 | 22.4  | 24.3  |
| Non-Bank Unsecured Loan                | No     | 8    | 17   | 36    | 61    |
|                                       | %      | 7.3  | 10.2 | 7.1   | 7.8   |
| Mortgage                               | No     | 12   | 24   | 58    | 94    |
|                                       | %      | 11.0 | 14.5 | 11.5  | 12.1  |
| Venture Capital                        | No     | 9    | 23   | 24    | 56    |
|                                       | %      | 8.3  | 13.9 | 4.8   | 7.2   |
| Government Grants                      | No     | 15   | 28   | 83    | 126   |
|                                       | %      | 13.8 | 16.9 | 16.4  | 16.2  |
| Credit Cards                           | No     | 16   | 37   | 65    | 118   |
|                                       | %      | 14.7 | 22.3 | 12.9  | 15.1  |

High rejection rates are found amongst new technology entrepreneurs using formal financial channels. 75% of new technology entrepreneurs who have attempted to use non-bank unsecured loans failed to access funding through this channel while 67% of those who tried to use business angel finance and mortgages failed. The rejection rates for new technology entrepreneurs are over one and half times higher than existing technology entrepreneurs in all three cases. Unsurprisingly the rejection rate from friends and family is relatively low with only 16.3% of those who used this channel failed. Nevertheless, the rejection rate from friends and family is higher for new technology than for old technology entrepreneurs suggesting that they are relatively less keen on lending to new technology entrepreneurs possibly due to higher risk involved in their ventures. Except government grant, the rejection rates are higher for new technology than for old technology entrepreneurs for all other sources. This suggests that like innovative product entrepreneurs, there is a financing problem for new technology entrepreneurs when starting a business.
The results presented in this Section and the proceeding section confirm the results found by other studies that the POH does not hold for TBSFs with a greater preference found for equity finance than debt finance. The remainder of this study will explore a different aspect of the funding problem, the reasons that entrepreneurs themselves feel have resulted in the failure to gain finance. Given the similarity in the characteristics of new product and new technology entrepreneurs with regard to choice of finance sources in order to preserve space the rest of the analysis of this study will focus on innovative product entrepreneurs rather than new technology entrepreneurs.

7. Main barriers to obtain finance for innovative entrepreneurs

The high rejection rate amongst innovative product entrepreneurs should be a major cause for concern given the importance of innovative entrepreneurs in the development of a vibrant and technologically-advanced economy. As such, higher rejection rates can act as a major hindrance for potential new products entrepreneurs attempting to start a business which can reduce the level of entrepreneurship and the level of economic activity particularly in areas of high potential growth. Therefore, there is a need to examine the causes of the high rejection rates in more detail. This study tries to look at this problem from the point of view of the entrepreneurs. The GEM UK survey asks the entrepreneurs who had been unsuccessful in obtaining finance, their opinion as to the reason for their attempts being unsuccessful. Results suggest that two of the most common causes for failing to access funding are not being investor ready and inadequacies in the business plan with over 50% of unsuccessful respondents in each case citing them as the main barriers. These are followed by the high cost of finance (45%), nature of business (37%), fear of debt (37%), unwillingness to share ownership of the business (35%) and finally weak management team (10.5%).
Table 8 Reasons for failing to access funding, by product innovation

<table>
<thead>
<tr>
<th></th>
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<th>Existing</th>
<th>Total</th>
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<tr>
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<td>40.0</td>
<td>32.4</td>
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<tr>
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<td>15</td>
</tr>
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<td>10.5</td>
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<td>4.1</td>
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</tr>
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</table>

(i) Inadequacy in terms of preparation

As mentioned earlier, inadequacies in terms of preparation either as not being investor ready or inadequacies in the business plan are cited by innovative product entrepreneurs as the most common reason for failing to access finance. Their respondent rates are much higher than that for partially new product and existing product entrepreneurs with innovative product entrepreneurs being twice as likely to cite these reasons than existing product entrepreneurs. The relatively high percentage of people citing inadequate preparation as their reason for failing to access funding suggests that there is a tendency for innovative product entrepreneurs to rush their products into the market without fully considering their viability. They appear to feel that there is a need to push the idea into the market as quickly as possible before someone else replicates their ideas and reduce their share of profits. This leaves them with little time to prepare for a business plan that is of an adequate standard.

Many innovative entrepreneurs are likely to be inventors of the new product themselves. They are often very gifted in science and technology but possibly lack the skills to transform their idea into a viable business. Consequently, they may have poorer business skills than other entrepreneurs. Table 8 shows that larger number of innovative product entrepreneurs are found to have problems with developing a strong management team than existing product entrepreneurs (10.5% compared to 4%). As human nature tends towards the familiar, innovative product entrepreneurs may be more willing to welcome like-minded individuals that are competent scientists and engineers but poor business planners into their inner circle within the business. From the other side of the argument, they may be reluctant to introduce business-minded individuals into their team due to difficulties in understanding and culture clashes that are likely to occur. This makes it harder for innovative product entrepreneurs to present their idea in front of business-minded bank managers and potential stakeholders.

Consequently, preparation is often beneath the required level. Potential problems arise such as lack of market research, costing strategy, patent and copyright and failure to produce a final product. Business plan preparation in particular is a major problem as 53% of innovative product entrepreneur respondents found it a major barrier as opposed to 19% for existing product respondents. As mentioned earlier, the inadequacies in the business plan may reflect the fact that the business is not ready to be invested in. At the same time it is also a lot harder to write a business plan about new innovative products. Banks and investors are less likely to be convinced by their forecasts on market size, growth potential, expected profit margins and level of job creation. As a result, many of these proposals are not perceived by banks and investors as legitimate.

These unsolved obstacles make it less likely for potential investors to be interested in investing in new innovative products. This is particularly the case for formal financial
institutions that require formal business proposal and conduct their own assessment through specialised in-house credit experts. Entrepreneurs themselves are aware of the problem and therefore, a large proportion of them at the end resort to informal finance and private investors rather than formal financial institutions. *Friends and family* and *short-term debt financing* are highly popular amongst *innovative product entrepreneurs*. *Equity finance* is also highly popular amongst *innovative product entrepreneurs* as it is believed that these private investors do not ask for formal business assessment. However, despite the relatively soft image, high rejection rate from equity financiers indicates that these lenders also make stringent assessment before they provide finance.

**(ii) Inadequacy in terms of cost of finance**

*Innovative product entrepreneurs* have great difficulty in obtaining affordable finance. 45% of *innovative product entrepreneur* respondents found *high cost of finance* as a major barrier to access finance compared to 23% for *existing product entrepreneurs*. The high cost of finance reflects the risky nature of their business as investors are more likely to raise the interest rates to compensate for the higher risk involved in innovative ventures.

**(iii) Unwillingness to share business**

*Innovative product entrepreneurs* are also more reluctant to share their businesses with investors. 35% of *innovative product entrepreneurs* reported *unwillingness to share ownership of the business* as a major barrier to accessing finance compared to 20.3% for *existing product entrepreneurs*. As mentioned many *innovative product entrepreneurs* are likely to be passionate about their product as they may have been heavily involved in its development, it is their baby. They are therefore less willing to give up their sole ownership right as it represents losing control of the product’s destiny.

8. **Conclusion and discussion**

Using GEM UK (2005) dataset, this study found that there is a liquidity constraint problem for start-up entrepreneurs using new products and technologies. The low attempt and high rejection rates for formal bank and other financial loans suggest that these sources are widely known by both *innovative product* and *new technology entrepreneurs* as difficult to obtain. At the same time the high attempt and high rejection rates for *innovative product* and *new technology entrepreneurs* for *business angel* and *venture capital* investors suggest that there is an incorrect preconception regarding the nature of these investors. We suggest that although these investors are likely to be less risk-averse when compared with formal financial institutions they are still cautious professional financial lenders who will examine the viability of their ventures thoroughly. Consequently, *innovative product* and *new technology entrepreneurs* are most likely to rely on informal source of finance such as friends and family, bank overdraft and credit card rather than formal sources of finance. The high attempt and low rejection rates amongst *innovative product* and *new technology entrepreneurs* for informal sources of finance suggest that they are rightly perceived as trouble-free uncomplicated sources of finance. However, while overdraft and credit card lending are costly, funds from friends and family can be relatively limited. Since the median required external start-up funds of *new product* and *new technology entrepreneurs* is higher than for those with established products and production technology this is likely to be major growth constraint. However, since GEM UK (2005) data does not provide information on the amount of loan required from each source of finance it is very difficult to assess the extent of the problem.

One policy implication of this study is that the government should re-consider their policy on enterprise training provision. According to GEM UK (2005) data, around a quarter
of the innovative product entrepreneurs have attended government enterprise training, which is consistent with the overall average figure. If as suspected innovative product entrepreneurs are less likely to have a business background it would be expected that participation in enterprise training schemes needs to be higher for this group. However, the relatively high rejection rates amongst innovative product entrepreneurs by formal financial lenders suggest that current government enterprise training programmes are either not taken up in sufficient numbers by innovative product entrepreneurs or where taken up do not cater specifically for these entrepreneurs.

This study suggests that innovative product entrepreneurs face very different financial obstacles when compared with entrepreneurs selling older products. In particular, their weaknesses in the business and management aspects of the production process should be a major cause for concern. Innovative product entrepreneurs are found less likely to possess the business skills required for start-ups and are less able to construct a management team capable of running business. In particular, lack of capability in writing business plan and proposal appears to be a major problem in obtaining finance. This may be due to their tendency to rush their products into the market without fully considering their viability or simply that they lack essential management skills to convince the investors. Further research is required to identify the source and the extent of the poor management problem.

Notes
1 In terms of the whole population of small firms, there are approximately 3.7 million businesses in the UK and 99% of these businesses employ less than 50 employees. In other words less than one percent of all businesses (just over 31,000 firms) in the UK are not small or micro businesses, (Curran and Blackburn, 2001). They contribute 46% towards non-government employment and 42% towards turnover. In 1999 over 450,000 people started their own businesses or became self-employed and in the same year over 400,000 businesses ceased trading (OECD, 2000). Similarly, over 95% of enterprises in the OECD area are SMEs and they account for 60-70% of jobs in most countries.
2 For example Amit, Glosten and Muller (1990) suggest that the entrepreneur’s abilities such as talent, skills, experience, ingenuity and leadership allow them to combine tangible and intangible assets in a novel way to be deployed to satisfy customer needs in an extraordinary way, are very important for the future returns from the venture capital investment. However, these abilities are hidden from venture capital firms (VCFs), and are specifically known only to the entrepreneurs (Bergemann and Hedge, 1998). This inability of the VCs to assess the venture founder’s skills and abilities may influence both the entrepreneur’s decisions whether to involve VCs, or not, and the VCs whether to invest in such ventures, or not. This situation leads to the asymmetry of information, which results in to moral hazard and adverse selection.
3 Himmelberg and Petersen (1994) and Jordan, Lowe and Taylor (1998) suggest that in innovative small firms, collateral values are typically low since the key strategic resource is often the knowledge embodied in the firm’s personnel, delaying access to some sources of finance compared to more conventional SMEs.
4 Internal finance sources can also include the personnel assets of the owner of the firm, as well as the assets held within the company.
5 However, according to BVCA (British Venture Capital Association) in 1994, later stage financing represented 94% of the total value of venture capital investments and 81% of the total number of projects financed. Similarly the EVCA (1995) states early stage and start-up funds, accounted for only 6% of the annual value of investments, whilst later stage financing accounted for 46% of funds invested.
6 Murray and Lott (1995) investigate the issue whether the UK venture capital firms have a bias against investing in TBSFs at their early stages. They find that US venture capital firms invest three times more than their UK counterparts in young new technology-based firms after excluding the Management Buy-in (MBI) and Management Buy-out (MBO) investments. In the US venture capital firms tend to invest more in the early stages of TBSFs whilst in the UK venture capital firms have a tendency to invest in MBOs/MBIs and in the later stages of TBSFs development.
7 Lethbridge (2003) suggests that it is comparatively harder for new innovative products based on new technology than established products based on known technology to get funding.
8 Although Table 2 shows the mean characteristics of nascent entrepreneurs’ start-ups, due to the tendency to be strongly positively skewed, median characteristics may be more representative, and are therefore also presented.
References


PRIME INNOVATION AND SUSTAINABLE ENTREPRENEURSHIP IN THE DUTCH RUBBER & PLASTICS INDUSTRY

Mrs. Hilke Elke Jacke Brouwers, M.Sc.

CIMO – Center for Innovation and Sustainable Entrepreneurship
Vrije Universiteit Amsterdam
De Boelelaan 1085
1081 HV Amsterdam – The Netherlands
020-5989921
Fax: 020-5989908
Hilke.Brouwers@como.vu.nl
Abstract
Since the explicit goal setting in the Lisbon Agenda 2010, the Dutch attention for technological innovation is growing to large proportion. The underlying research will focus on the integration of innovation with sustainable entrepreneurship as central notion and the translation of generic guidelines for reporting on sustainability issues into a zero assessment model for sustainability innovations within small and medium-sized companies. The results of the PRIMA project, carried out within the rubber and plastics industry will be demonstrated as an example of explorative research into this field. It will show that many innovations for sustainability are directed at process variables, such as reduction of resource use, energy saving programs and recycling. Companies with more ‘sustainability in the core’ also show innovation in product design and development of new technologies. Knowledge circulation between the consortium partners provides useful insights in new methods for sustainability innovation.

1. Introduction

Since the explicit goal setting in the Lisbon Agenda in 2000 for the members of the European Union to become the world’s most competitive region by 2010, the Dutch attention for technological innovation is growing to large proportions (www.innovatieplatform.nl). Europe lags behind Japan and the United States and need to catch up. Key to address this problem is to innovate more and better than close competitors. To accommodate this policy, the Dutch Government has installed the Innovation Platform, presided by the Prime Minister. Its goal is to strengthen the innovation potential of the Netherlands in order to secure a leading role for the country in the European knowledge economy in 2010 (Innovatieplatform, 2006, The Dutch Innovation Platform. Den Haag)

Also in recent years, researchers have become increasingly interested in innovation theory and the transfer of knowledge. The topic of innovation has been a fruitful source for publication. Innovation is thought to be the main driver for economic development and business competitiveness. In the light of economic recession, these two become more and more important.

According to the sustainable development concept, the direction for innovation and innovation policy should be aimed at improving on economic as well as environmental and social performance. New technologies must be developed to meet sustainability requirements set by society and government. Until now, sustainability innovation and sustainable entrepreneurship are mainly addressed and/or communicated by large companies.

However, the direction for sustainable innovation policy is unclear and under discussion. The main focus for innovation policy is sought in stimulating and facilitating large, often multinational, companies via highly subsidized R&D trajectories. Although these companies contribute significantly to the gross national product and employment rates within the country, the role and significance of small and medium sized enterprises (SME) should not be underestimated. SMEs employ between the 1 and 250 employees per company. They cover over 90% of the total number of enterprises in The Netherlands, accounting for 58% of the employment rates and 51, 5 % of the annual turnover (www.mkb.nl). Also, there are significant differences between large companies and SMEs in innovation processes. Policy AND theory
suited for large companies, does not necessarily lead to successful outcomes within SMEs. It is acknowledged by diverse actors (government, business networks, scholars, etc.) that specification for SMEs is necessary and wanted. For SMEs however, the translation of the sustainability concept into hands-on, daily business strategy and action, is scarce. The publication of ‘High 5’ by the Global Reporting Initiative in 2005 is one of the few guidelines specifically aimed at SMEs.

The aim of the present paper is to give more insight and empirical evidence on the translation of the generic approach for innovation for sustainability into a SME and sector specific assessment model and the transfer of knowledge on innovations for sustainability between SMEs and knowledge institutions. This will be done by presenting the results of the PRIMA (Prime innovation and sustainable entrepreneurship) project. The Global Reporting Initiative (GRI) guidelines for SMEs on sustainable entrepreneurship are the starting point of this translation and assessment model.

The relevance of this explorative research lies in the importance of innovation for economic growth and business competitiveness, but also a necessity and urge to integrate sustainability aspects in innovation processes, in order to address current and future stakeholder needs and demands. The PRIMA project was initiated by a unique consortium of knowledge institutions, companies and intermediate organisations, which deserves follow-ups.

The results of the present research will indicate that the PRIMA Barometer as a sector specific SME model, proved useful and successful to assess the status quo within SMEs of the Dutch rubber and plastics industry on sustainable innovation and entrepreneurship.

The remainder of the paper is organized in the following way. Section 2 forms the theoretical background of the research, focusing on innovation, SMEs and sustainable entrepreneurship. Section 3 discusses the research methodology and the construction of the zero assessment model. Section 4 discusses the empirical results and section 5 discusses the conclusions. In section 6 some suggestions for future research are provided.

2. Theory
In the following discussion the most prominent research in the field of innovation, SMEs and innovation for sustainability will be described and illustrated.

Innovation
It has commonly been assumed that innovation is the main driver for economic growth in macroeconomic terms. Innovation strengthens the competitiveness for countries as well as for sectors and individual companies. A continuous strive for improvement and renewal of a company’s products, processes and organization will contribute to the profitability and continuity of the firm. It leads to quality improvement, increasing variation and diversification in products, increased productiveness and a positive influence on turnover, profitability and employment (Lever & Meijaard, 2003). Other advantages of innovation are protection or extension of market shares, improved operational efficiency, increased employee satisfaction, retraction and competencies, increased reputation and cost reduction. Innovation can either strengthen a firm’s existing capabilities and market position, or it may be disruptive by rendering competencies
obscure or reaching out to new customers and so-far unserved markets (Abernathy & Clark, 1985)

A theory of innovation is fundamentally a theory of change. Innovation research is typically concerned with understanding how innovation emerge, develop, grow, and are displaced by other innovations (Hockerts, 2003). Innovation studies regularly make citations on the work of Joseph Schumpeter, which is the representative of the Austrian school of Innovation theory. His ‘Theory of Economic Development’ (1934) delivers a broad interpretation of innovation: it comprehends the introduction of a new product, process method, the discovery of a new resource, material or semi-manufactured article, the conquest of new markets and the building of a new organization. Innovation is a process and outcome of ‘creative destruction’ and is directed at developing new combinations of resources. Whereas Schumpeter speaks of creative destruction, more recent researchers focus on utilizing chances (Kirzner, 1973), goal oriented innovation (Drucker, 1985) and risk taking behaviour (McGrath, 1999). Key to this tendency is that it does not differentiate between different kinds of innovations, the ‘newness’ of something suffices as discriminator. However, the newness of the innovation is less relevant than the fact that the ideas, practices or objects are new to the operational unit which is adopting them (Bhaskaran, 2006)

In order for an innovation to be effective, or even successful, it must result in a significant change, preferably an improvement in a real product, process or service compared with previous achievements (Harper & Becker, 2004; Amabile, 1997). That this is not an easy task proves that only 1 out of 7 ideas make it to the market (Gobelli & Brown, 1993)

Innovation theory does not just focus on quality improvement or cost reduction, but also on radical ‘breakthrough’ innovations. Innovation theorists have tended to draw a distinction between the mentioned ‘newness’ of innovations, which then distinguishes ‘radical’ and ‘incremental’ innovations. Incremental innovation introduces relatively minor changes to the existing product, exploits the potential of the established design, and often reinforces the dominance of established firms (Ettlie et al., 1984). Radical innovation, in contrast, is based on a different set of engineering and scientific principles and often opens up whole new markets and potential applications (Dewar & Dutton, 1986). Another issue that is consistently discussed in the literature pertains to measuring and quantifying innovative behaviour (Johannesson, 2001).

The debate on defining innovation is still ongoing and there are almost as many definitions as there are researchers. This underlines the importance of setting research boundaries when using ‘innovation’ in research. For use in this research, innovation is defined as the development and successful implementation of a new or improved product, process, service or organization, which is new to the company or the market, and is aimed at improving the profitability and competitiveness of the company.

**SMEs**
Most research on innovation applies to innovation processes in large companies. The innovation process for SMEs however, is different from that of large companies. In short: a SME is not a little big business. SME characteristics can be summarized as followed:

- Resource poverty in terms of capital, time and skilled personnel (knowledge)
- Focus on the short term
- Flexible organization capacities
- Dominant role of the entrepreneur/owner
- Performance measurement in terms of labour productivity rather than profit and growth
- Strong local and regional focus
- Large proportion of family enterprises
- Equipped for niche markets (Heunks, 1998; Welsh & White, 1981; Masurel et al., 2003).

Innovation & SMEs
More than large companies, innovations of SMEs tend to concentrate on applying basis technologies, implementing applied research results from university ‘spill-overs’, generating new inventions and occupying niche markets. When focusing on sales and marketing innovations, SME innovations are profitable and able to compete successfully with large businesses. Typically, SME innovations can be seen as incremental innovations, which also can lead to substantial competitive advantage (Bhaskaran, 2006).

As pointed out before, the SME is dominated by the entrepreneur/owner. The effectiveness of personal and business contact networks and relationship bonding with individuals in government, research and development corporations, universities and industry in the successful uptake of innovation has been extensively research and discussed in several studies (Merrilees et al., 2000; Barkema et al., 1997). The significant issue is that individuals vary in how they process and interpret knowledge and these variations may have significant but systematic impact on the decision to become an entrepreneur or the relative success of the endeavour (Acs, 2002). Therefore, the individual entrepreneur plays a vital role in the successful development and implementation of an innovation. To increase the chance for innovative success, cooperation with other actors is useful.

SMEs have advantages over large companies for innovating, because of their management structure (bureaucratic vs. small decision making body), their bureaucratic constraints free environment, their placement of innovative activity at the center of competitive strategy and their ability to use university laboratories spillovers for commercial exploitation (Acs, 2002).

Sustainable entrepreneurship
Many scientific publications within the sustainable development concept start with drawing the dramatic scene of a ‘dying earth’, or a composition of the state of the world which is at the least of mild concern. Many hot spot cases, such as the financial fraud at Enron and the ‘battle’ of the Brent Spar between Shell and Greenpeace are frequently referred to as incentives for companies to engage in new ways of doing business.

Reviewing the literature, there appears a clear demarcation line marking the beginning of the concept: 1987, with the publication of the report of the World Commission on Environmental Development (WCED, 1987). It defines sustainable development as “seeking to meet the needs and aspirations of the present, without compromising the ability to meet those of the future”. The notion of sustainability was originally thought of as development that seeks to be continuous amidst worries that existing development will be resource constrained by the carrying capacity of Earth’s natural resources and ecosystems. Elkington’s book Cannibals with Forks (1997) delivered the now widespread idea of the triple bottom line for sustainable development: People -
Planet - Profit. It requires organisations to fundamentally rethink their position and act in terms of the complex societal context of which they are part (Van Marrewijk, 2002).

Just as with the definition for innovation, sustainable development for companies knows as many definitions as there are companies. Literature shows deficits on defining definitions AND direction for sustainable development. It ranges from doing something with the environment’ to ‘closing production chains and having no negative impact whatsoever.

Next to this definition problem, sustainable entrepreneurship has its critics. They point out the risk of window dressing within companies that use the concept as a promotional tool. There are also issues with measurability (which indicators to use), playing an important role in the present research. Also the notion that sustainable entrepreneurship knows no blue-prints for implementation, the often fragmental approach for this holistic concept, its Western cultural bias and acting beyond legal requirements, reveals these critiques (see Wilson & Olsen, 2003 for a descriptive overview).

However, the concept has attracted the attention of many, including business. Nowadays, there are a number of motivations that explain the relevance and importance of the concept for companies as summarized below:
- Strategic advantage
- Profitability
- Increasing stakeholder pressure
- Legal requirements
- Reputation concerns
- Environmental performance improvement
- Internal organisation improvements (Ranganathan, 1998; Van Marrewijk & Werre, 2002; Dunphy et al., 2003; Daily & Walker, 2000).

These motivations clearly resemble the advantages of innovation. Sustainability is an innovative and in potential transformative force that generates new products and processes that challenge existing practice.

**Innovation for sustainability**

Aiming to achieve a prosperous, profitable and accountable business future, there is clearly a need for fundamental industrial change that will depend on technological and social innovation, understood from the social, political and economic forces that shape it (Blum-Kusterer & Hussain, 2001). Sustainable innovations usually have a more radical or transformational character than conventional innovations (Rycroft & Kash, 2000). Sustainable innovations are based on the belief that, in order for an organization to survive, innovations must be introduced to create new opportunities, but with extra conditions, attached to their implementation. The same applies for their necessary contribution to a sustainable society, which has constantly changing requirements.

Whereas innovation in the present research is defined as the development and successful implementation of a new or improved product, process, service or organization, which is new to the company or the market, and is aimed at improving the profitability and competitiveness of the company, innovations for sustainability / sustainable innovations aim also on environmental
Innovation for sustainability is characterized by introducing and implementing new products, processes, services and organizations which improve the economic, environmental, technical and social performance of a company on the short and long term. It integrates stakeholder demands into decision making and aims at a transformational change of existing practice.

As with innovation within SMEs, research into sustainable entrepreneurship and innovation within SMEs is scarce. On the one hand, a number of scholars argue that SMEs are hardly active in the field of sustainable entrepreneurship (e.g. Hillary, 2000; Hutchinson & Hutchinson, 1996). On the other hand, there are scholars who oppose to this point of view (e.g. Petts et al., 1999). In the present research the assumption is made that advantages for SMEs to integrate sustainable entrepreneurship at the core of the company are comparable to those of large companies, thus indicating the same amount of necessity and urgency. However, there are some conflicting aspects of sustainability innovation within SMEs. On the positive side are the commitment, personal involvement, creativeness and flexibility of the SME, which favours sustainability innovation. On the other hand a resource scarcity (capital, time and knowledge) can be found within those same SMEs. Also the focus on the short term, in stead of the long(er) term conflicts with the character of sustainability innovation. The incremental nature of most SME innovations also conflicts with the demanded transformational ability of sustainability innovations. In short: SMEs can be very innovative; the question remains whether their innovations can be marked as innovations for sustainability. When taking on the view that the future only comes nearer day by day, small steps in the direction of sustainability are maybe the highest possible expectancy towards SMEs.

3. Method of Research

As shown in the theoretic section, SMEs are not little big businesses. Therefore, guidelines and instruments developed and used for large companies must be translated into those for SMEs. To address this need for translation of generic guidelines and technological insight specifically on sustainability innovations within SMEs, the project PRIMA ('Prime' innovation and sustainable entrepreneurship) was carried out in the period October 2004 – December 2005 in the rubber and plastics industry. The project itself was aimed at:
- Developing an indicator scan (the PRIMA Barometer) to translate generic into sector specific sustainable innovation and entrepreneurship assessment indicators
- Circulation and transfer of (technological) knowledge on sustainability innovation between SMEs and knowledge institutions.

PRIMA has led to the constitution of a consortium of knowledge institutions including 4 schools of professional education (Windesheim, Zwolle; Avans, Breda; Fontys, Tilburg and InHolland, Alkmaar), Syntens, the Vrije Universiteit Amsterdam’s Center for Innovation and Sustainable Entrepreneurship (CIMO), and the Federatie NRK (sector organization for the Dutch rubber & plastics industry. This constellation is fairly new and unique in its kind. The installation of the sustainability readerships in the schools of professional education made this consortium and cooperation possible.
In 1997 the GRI developed some 100 indicators for their reporting guidelines on sustainable entrepreneurship for large companies (www.gri.org). These guidelines have proven useful to indicate the performance on various sustainability issues today. Each change process must begin with the assessment of the status quo in order to be able to define improvement possibilities. When used as a starting point for indicating improvements on economic, environmental and social improvement, they can initiate innovation for sustainability. Recognizing the special characteristics and needs of SMEs, the GRI has recently published the “High 5” guidelines (2005) for these companies. They are a much needed translation to a more hands-on approach.

The present research aimed to develop a translation of the generic High 5 and GRI guidelines into a sector specific assessment model on sustainable entrepreneurship and innovation (the PRIMA Barometer). This is needed because of the assumption that context and entrepreneurship centrality play a vital part in sustainable innovations. The High 5 guidelines focus more on describing a 5 step plan to adjust the GRI guidelines (for larger companies!) to the specific business situation. The High 5 outlines are the following:

1. Prepare: getting started (form a sustainability reporting team/determine resources available/develop timeline for activities)
2. Plan: what to report (describe vision, activities and goals / map stakeholders and interests / set scope & reporting boundaries)
3. Assess: measure your performance (identify GRI indicators / collect information / set targets for next year)
4. Report: tell the news (choose communication method / write & distribute report)
5. Improve: strive for more (collect feedback for improvements).

High 5 is an approach for SMEs to do their own reporting on sustainability indicators. There were no new indicators developed for SMEs, based on SME characteristics. In other words: no real translation was made to the SME level. Another shortcoming in the GRI indicator set is the assumption that organizations have a formal structure based on disciplines (i.e. a logistic staff, an R&D staff, etc.). However, in SMEs there is usual an absence of these formal structures. Innovation and entrepreneurship are informally organized. A portion of the indicators of the GRI therefore cannot be applied, but that doesn’t mean the sustainable innovation performance is consequently lower. The guidelines are also mainly intended to serve as a communication tool, rather than an organizational improvement instrument.

In the PRIMA project, the consortium, containing experts on innovation, sustainable entrepreneurship, SMEs and the rubber and plastics industry, discussed thoroughly during brain storm sessions, on how to approach the assessment of the companies on their innovation and sustainable entrepreneurship performance. Instruments which are available for assessment and change pathways, suited for use within the sustainable entrepreneurship context were studied. Starting with “High 5”, also a number of other implementation schemes, tools and instruments were studied (NOTE 1). A set of indicators was chosen as subjects for the assessment.

Another important factor in constructing the assessment model was the available time to conduct the assessment. The information gathering had to be done within the framework of a 2 to 3 hour interview between a student/lecturer and a representative of the participating company. The GRI
framework is not specifically time limited: the indicators and information can be gathered at the company’s own speed.

Core elements of the PRIMA Barometer are strategy (organizational aspects), processes and products (including services). The Barometer resembles an interview guide, with open answer possibilities. Whereas many models choose to include answer categories, for instance based on Lickert-scales, the purpose of the PRIMA Barometer is not to ‘score points’, but indicate what is really going on. The background of this notion is that a ‘good’ score on (sets of) indicators does not stimulate the implementation of improvement programs, and that the allocated scores are often subjective and based on perception, not facts. For example, the ISO 14001 certification for an environmental management system may achieve high marks, but doesn’t necessarily say anything of the state of environmental performance of a company. A company with certification doesn’t necessarily outperform a company without one.

The design for the assessment model includes indicators which are derived from the “High 5” guidelines and are inspired by the instruments mentioned in note 1. The found indicators were inventoried and categorized, using mind-mapping techniques. The Barometer is formulated as an interview guide, including the following topics:

1. Company characteristics
2. Financial performance
3. Product quality
4. Working conditions & Safety
5. Environmental management
6. Ethics & transparency
7. Societal focus
8. Innovation
9. Product cycles & dematerialization
10. Renewable resources & energy

The PRIMA Barometer is used during company visits by the participating students and lecturers of the schools of professional education located in the three defined regions. They worked together with local representatives of Syntens and were advised by a representative of the Federatie NRK. A total number of 38 companies participated in the program. The visited companies received a report and analysis on their innovation and sustainable entrepreneurship status quo, alongside with advice on where to start sustainable innovation projects.

The PRIMA project also included an Award event as part of the celebration of the 65th birthday of the Federatie NRK, to pinpoint the Innovation and Sustainable Entrepreneurship Rubber & Plastic Company of the year. In two voting rounds, a regional and a national jury, presided by the chairman of the Federation NRK, awarded the Gold, Silver and Bronze PRIMA Award to three “Champion” companies, which were presented with their prize by the Prime Minister Balkenende during the National Innovation Event 2005.
4. Empirical Findings

This limited investigation ventures to demonstrate how the zero assessment model can be used for determining the status quo on sustainability innovations and entrepreneurship within SMEs of the rubber and plastics industry.

Sector description

Both innovation and sustainable entrepreneurship highly depend on the context for the shape in which they arise. Context characteristics refine the approach and possible outcomes of sustainability innovation. It hardly needs explanation that sustainable innovation for e.g. a financial institution or software company differs from that for an industrial company producing for instance plastic shopping bags.

The present research focuses on industrial SMEs, specifically within the rubber & plastics industry sector. The sector, including some 1100 companies, consists mainly of SMEs (95%) and has a strong export focus (about 65%). The overall turnover is about 6 billion euro. The companies produce and supply a variety of (semi) finished products to industry, building and construction, packaging and consumer products. In numbers: 37% of all plastics go to packaging, 24% to industrial purposes, 20% to consumer products and 19% to construction materials (www.nrk.nl, Economisch Bureau ING, 2005)

The relevance of the rubber & plastics industry is found in the fact that this high tech sector is awarded the title ‘Most innovative sector in the Netherlands’ by the EIM (Dutch Economic Institute for SMEs) in 2005. The sector is further characterized by the application of a diverse range of high tech production technologies, such as vacuum injected moulding, multi layered moulding, composite technology, extrusion, and biopolymers. The sector delivers high tech products, which serve innumerable markets. Companies within the industry are often suppliers in product chains. This leads to the ability to adapt to client demands and market pressures. Innovation within this industry is market-oriented. The necessity for innovation is clear from international competitiveness point of view. The state of the economy and production replacement to low-wages countries impose pressure on the industry to specialize and differentiate. A cost reduction prize-induced innovation strategy will not suffice to maintain a leading position on the market.

The response group of participating companies in the PRIMA project include a representative overview of the variety in company sizes (between 10 and 250, with 2 companies with more than 250 employees [350 and 550 employees respectively]), products, processes and markets served within the rubber & plastics industry.

Performance variance

- Strategy
The smaller companies in the research group do not have a formal innovation strategy which is documented in the organization. The larger companies (more than 100 employees) often have formulated innovation goals, such as targets for improvements on cost reduction, energy use,
innovative output and development of new products. Even without a written strategy, a number of the smaller companies have innovation ‘in the core’: it doesn’t need to be explicit, because innovation is core element of the company. This attitude is mostly found in the younger companies (>2000). Innovation strategy includes a proactive, creative, honest and trendsetting attitude towards markets. Products and services must create added value for the customers, e.g. total support systems, time and labour reductions and performance improvements.

What all companies studied have in common is the central motivation for (sustainable) innovation based on economic performance of the company. This is by itself not uncommon, because continuity requires an economical healthy business. Even so, economic motives for improvement and innovation processes are the main drivers for the companies. Environmental or social aspects are not by themselves drivers for innovation. They must be accompanied with economic advantages to be acted upon.

For some of the companies, innovation only takes place out of cost reduction motives, often demanded by clients. There are also companies which do not characterize themselves as innovative. Others are inspired by new market possibilities, material possibilities and integrated design. Most companies innovate from a product point of view. There were only two or three companies that innovate from an integral design concept, which is inspired by the intended use of the client and the possibilities of design in defining new functions of products.

It is common for the companies that reached the status of PRIMA Award Nominee in the research group to cooperate with horizontal or vertical related companies, knowledge institutions, design bureaus, industry contact groups and sector organizations. Here also the participation in government subsidized R&D programs can be found.

As pointed out in the theoretical section, the SMEs do not have a strong focus on the long term regarding their innovation strategy. The focus is survival, competitiveness and added value today and tomorrow, less on periods more than a year ahead. With this in mind, most innovations are not radical by nature, but incremental. Some do have transformation abilities, such as the replacement of resources by sustainable ones or renewables and the use of sustainable energy resources.

- **Products**
  Most innovative products are innovative by design or function. Regarding the sustainability aspects of these product innovations, these improvements can be found in reduction in weight, energy or material use or because they improve recycle options in the waste phase of a product. Only a few companies have products with innovative material use, e.g. hemp fibre for composite applications or biopolymers as substitute for oil-based materials. Although a large portion of production is export-oriented, there are hardly products designed and developed for use in developing countries. One company in the research group specifically invented “universal glasses” for these countries. Still, this innovation was not a ‘core activity’ of the company.

- **Processes**
  Innovation in processes is either focused on cost reduction (faster, bigger, more automation/robotization, improving internal logistic processes) or introduction of new
technologies (such as sheet layer moulding, vacuum injected moulding, composite technology, drape forming, gas-assisted moulding and micro-milling). When a fairly unique technology for the market is incorporated, it provides significantly competitive advantage.

As a whole, the group of companies has their legal environmental and social requirements in working order. Although legal requirements can stimulate innovation, in this project is sought after other stimuli for innovation.

The sustainability focus is for the main group relatively low and usually covered within issues as environmental impact of emissions (to water, air, and soil). Only a few companies were sustainable ‘at the core’ and focused their innovation efforts in including environmental and social aspects in improving process elements. It seems again that the individual inclination to think from an integrated and sustainable starting point is the main discriminator between truly sustainable innovators and innovators with attention for environment and social aspects.

- Knowledge circulation

The interaction between the knowledge institutions and the companies proved fruitful. A circulation of knowledge between the companies and the schools of professional education as shown in fig. 1 emerged.

One the one hand the students learned a lot on how sustainability issues and innovation is handled within SMEs of the rubber and plastics industry. They enhanced their knowledge level on techniques and innovation approaches specific to this industry. On the other hand the companies in return got a fresh and outside look on their operations and often good starting points for improvement. They provided the knowledge institute with specific information and by doing so, improved the definition of possible problem fields within the organization. This circulation process proved self-enhancing, because information and knowledge sharing enhanced the knowledge level on both sides.

The technological knowledge transfer was relatively low, mainly caused by the background of the students and lack of training in plastics-specific technology at their institution. Even so, the specialities of the lectors involved gave useful insights in new technological developments in the fields. For the companies it is also a welcome communication line with possible future employees.

The assessment model proved useful in assessing the companies on their economic, environmental and social traits and performance in a detailed form. Although not intended to make rankings between participating companies, it was possible to select three Innovation & Sustainable Entrepreneurship Award winners. This could only be done with thorough discussion on the relative importance of the investigated performance parts. This indicates also one of the
weaknesses of the model: there is no weighing involved in the assessment. This is also its strong point, because weighing is only useful within the context and possibilities of the company.

6. Conclusion & Discussion

This descriptive and explorative study into the translation of generic guidelines into a sector specific zero assessment model for describing innovation and sustainable entrepreneurship within the rubber and plastics industry, has uncovered several important factors that are associated with the characteristics of both sustainable entrepreneurship and innovation within SMEs.

The results on the assessment model show that there is in fact a balancing act within the participating companies to integrate social, environmental and economic factors in innovation processes. They are mainly driven by economic advantages, but nevertheless in place. Innovation within the companies focuses generally on two aspects: product development (often incremental innovation) and process enhancement by the introduction of new technologies. Although some of the elements of innovation for sustainability are in place, such as combining and balancing economic, environmental and social elements within innovations, most innovations in the research group cannot be seen as ‘true’ sustainability innovations. The main ‘problem’ here is the incremental and short term character of innovations within the studied SMEs. In order for an innovation to be truly sustainable in nature, these elements must be included. However, it goes too far to say that there is no such thing as sustainability innovations within SMEs. The clue is in the size of the steps towards sustainability. In the end, sustainability is a dynamic concept: the dependence on future needs and stakeholder demands will shape the direction and improvements necessary to follow it. It can only become better. The PRIMA Barometer suited the purpose of the PRIMA project with its limited time resources very well and this is also one of its main advantages above the generic GRI guidelines: it does not take a lot of time to uncover sustainability performances of SMEs, which is a good thing, because SMEs also have limited amounts of time for ‘non-core’ activities (i.e. things that do not necessarily include organization productivity). An other advantage is the

The results on the knowledge circulation show that a self-enhancing communication on knowledge about sustainability innovation is developed, which provides a win-win situation for all parties involved. The consortium proved to be effective, but still will need maintenance in order to be sustainable itself. Regular contact moments are therefore required, accompanied with knowledge transfer and feedback.

7. Future Research

This issue deserves further empirical study, also because of the body of research on the subject of sustainable innovations within SMEs is fairly scarce and fragmented. Another promising line of research would be to carry out the same analysis in other sectors and to repeat the assessment within the rubber and plastics industry during the course of several years (maybe even decades) to uncover sector and time related developments and success variables for sustainability innovations.
Notes
1. Sources for implementation schemes, tools and instruments for assessing sustainable entrepreneurship and innovation include NGOs, Consultancy firms, Academic researchers, business councils, and knowledge institutions. For an overview, see Brouwers, 2004.

References


THE NETWORKING AND GLOBAL AWARENESS OF YOUNG TECHNOLOGY-BASED ENTREPRENEURS: A CASE STUDY OF THE MASTER OF ENTERPRISE (MENT) PROGRAMME OF THE MANCHESTER SCIENCE ENTERPRISE CENTRE

Frank Cave, Lynn Sheppard, Jingfei Xiao and Rowena James

Lancaster University Management School and Manchester Science Enterprise Centre, The University of Manchester

Contact: Dr Frank Cave, IEED, Lancaster University Management School, Lancaster, LA1 4YX, UK.
Tel. +44 1524 594057, e-mail: f.cave@lancaster.ac.uk.
Abstract

This study addresses the networking and global awareness of young technology-based entrepreneurs (YTBE). It is based on six technical entrepreneurs who graduated from the Master of Enterprise (MEnt) programme at Manchester Science Enterprise Centre.

The main purpose of this research was to determine if YTBEs realise the importance of networks to business success and whether they act positively to build them. The second purpose was to see if they consider international opportunities and whether they build skills to sense and act upon them.

The results have policy implications for supporting the development of the high-technology SME sector and providing insights into the internationalisation of high-technology SMEs. The research found that the YTBE from this course, show highly positive perception towards networks. Policy-makers are encouraged to nurture and further develop this type of human-based incubator. The investigation of global awareness of the young entrepreneurs shows less optimistic results. This situation should give cause for concern to both educators and policy makers.
Introduction

Recent research shows that networks and global expansion or internationalisation contribute to the success of small and medium sized enterprises (SMEs), especially for technology-based enterprises (Beibst and Lautenschläger 2004; Jones and Conway 2004). It has also been shown that networks are associated with financial benefit (Baron & Markman 2003). Entrepreneurs of technology-based firms usually have a science or engineering background, and are generally believed to consider the technology paramount in business success (Cooper, 2000). Dealing with science and technology most of their time, they are regarded as poor at networking, if not reluctant to do so.

Hence young technology-based entrepreneurs might be at a disadvantage since networks are generally better developed with age. Conversely, with the growth of international travel by young people, they might be at an advantage in thinking more internationally than their elders.

The questions the research aimed to address were; Are the entrepreneurs who graduate from formal technology entrepreneurship education programmes aware of these key factors and do they try to address them to improve their chance of success?

To answer these questions the paper first addresses the definition of a technology-based entrepreneur in relation to the target group. Some analysis of the concept of networks is presented moving from the general to the specific, i.e. network, social network to social capital. A review of the debate on reasons for thinking and acting globally is given to justify the need for global awareness in YTBEs.

The definition of the technology-based entrepreneur

It is important to be clear about the meaning of the technology-based entrepreneur at the outset. As Cooper commented; “research in the field of technical entrepreneurship is still at a relatively early stage compared with its ‘big brother’ of general entrepreneurship” (2000:226). The majority of technology-based entrepreneurs have science or engineering strengths and the enterprises they start (knowledge-based or technology-based firms); ‘develop products and services arising from advanced technological research or … base their activities on the application of advanced knowledge’ (Garavan and O’Cinneide 1994:19). As a result, the founder’s knowledge and expertise is usually the basis of his/her firm’s competitive advantages (Cooper 2000).

There is however not a widely accepted definition of the ‘technology-based entrepreneur’. Jones-Evans (1995) held the view that a technology-based entrepreneur is ‘the founder and current owner-manager of a technology-based business, i.e. primarily responsible for its planning and establishment, and currently having some management control within the organization. While Smith (1967, cited in Cooper 2000) presented his view that it was not necessary that the entrepreneur should be involved in the subsequent management after the
setting-up of the new business. This paper supports the first opinion, as the involvement of the entrepreneur in the early life of a leading-edge technology firm has a significant contribution to the firm’s growth and development. The technical entrepreneur knows most about the commercialised technology and therefore is capable of providing valuable insights into the business strategies and business decisions, based on a thorough understanding of the technology. A management which excludes the technical entrepreneur runs the risk of mis-positioning the product as well as being unable to foresee trends in the technology.

The technical entrepreneur has a vital influence on the survival of the enterprise, but for most of them the road to business ownership is not ‘golden’ (Cooper 2000:227). He/she requires a combination of skills and expertise to overcome the challenges. Networking behavior and global awareness are useful tools for the entrepreneur.

Networking

Traditionally, the influence of networking is disregarded as being of great importance for the success of entrepreneurs as they are often portrayed as heroic individuals who value their independence and are reluctant to depend on others. This myth is deconstructed with the development of entrepreneurial theory and it is now accepted that networks and networking are ‘important entrepreneurial tools that contribute to the establishment, development and growth of small firms’ (Shaw and Conway 2000: 368).

Work has been carried out exploring networks of small-business such as the Silicon Valley cluster in USA (Saxenian 1990) and the Cambridge Biotechnology cluster in UK. It was found that SMEs can enhance their competitiveness via collaborative arrangements within this networking (Shaw and Conway 2000). The network of support organisations and umbrella organisations was commented on as the ‘catalyst’ for small-firm networking activities, helping to establish, develop and grow SMEs.

Another perspective focuses on the personal contact network of the entrepreneurs. Carson et al. (1995:200) pointed out that this network, the small firm’s ‘social network’, is ‘the relationships or alliances which individuals develop, or may seek to develop, between them and others’. The last fifteen years has seen the social network theory becoming a major research interest in the area of entrepreneurship (Hoang and Antoncic, 2003). Literature supports the claim that the social network plays a critical role in the small firms’ lifecycle, both in a time- and cost-efficient manner (Johannisson 1998; Chell 2000; Neergaard 2005).

Latest studies move the focus of social network one step further to identify the entrepreneur’s ‘social capitals’ - friends, acquaintances, colleagues and contacts through whom a social actor ‘create[s] opportunities to utilise their financial and human capital’ (Burt, 2000:282). Myint et al. (2005) offered an insight into the contribution of human elements in shaping the Cambridge incubator into a global high-technology cluster. They argued that it is not the buildings, physical facilities and value-added services in the offices that made the Cambridge incubators a great success but the social capitals accumulated and the networks built
Global awareness

Due to the rapid development of information and communications technologies, the traditional segmentation of large companies competing in international markets and SMEs competing in local and regional markets has been broken. The internet enables SMEs to compete with large companies on the global stage and this dramatic change calls for the global awareness of entrepreneurs in order to take advantage of this opportunity.

Global awareness, not only refers to the awareness that internationalisation is a workable option for the developing firm, but also refers to the awareness of an international focus in the business, thinking globally and acting globally (Beibst and Lautenschläger 2004). Internationalisation is crucial for the survival of high-technology SMEs and research needs to be carried out in order to grasp opportunities, or even to create opportunities that help firms to cross borders. Hence, it is necessary that YTBEs be sufficiently aware of the global opportunities in order to address the challenge and respond appropriately.

Researchers question if the different stages of internationalisation still apply to the new-technology start-ups, or so-called ‘born global’-small firms ‘spawned’ by new technology-based development (Matlay and Mitra 2004). Rosson (2004) argues that the convention that firms expand into foreign markets after home market success does not make sense anymore, especially in such a robust age of information explosion and shrinking of the Earth to a global village.

The severe competition faced in global markets does not allow SMEs the luxury of time to grow from a strong home base (Sawhney and Mandal 2000). Technology-based SMEs are threatened by the rapid obsolescence of the products and technology on which their core competitiveness is based. In an age when the interval of knowledge renewal becomes shorter and shorter and new products emerge ever more rapidly, even a cutting-edge technology may not be able to maintain its advantage for long. As a consequence, the earning opportunities of technology-based SMEs decrease severely with time (Beibst and Lautenschläger 2004). For this reason, those adopting a first mover strategy worldwide gain the time to set up product standards within their market niche, which might create obstacles for the late comers. Research shows that the early entrant tends to enjoy the largest market share while the delay in expansion is costly (Rosson 2004).

New technology based firms tend to have a narrow product scope and a limited home demand; they should therefore position themselves on an international if not global niche from starting up (Litvak 1990). However internationalisation is a double-edge sword which raises many risks for SMEs. The heavy cost of an international operation is an additional burden to an SME’s often very limited resources. Operating in an unfamiliar foreign market environment is difficult; different cultural identity may result in low market acceptance. For the majority, internationalisation accelerates and increases the competition with foreign enterprises and brings in competitive challenges and threats sooner than anticipated (Szabó
2002). For this reason, Harper and Previts (2002) strongly asserted that being passive to change instead of adopting the change is more risky than the change itself.

The impact of networking on internationalisation

Small firms are heavily reliant on networks at the beginning of their internationalisation, especially when selecting foreign markets to target and expand into (Crick and Spence 2005). For the purpose of correctly positioning the product in less familiar overseas markets, stimulating interest, gaining insight into the markets and building good business relationships based on trust and understanding, entrepreneurs must interact with potential business partners, clients, agents, representatives and others to discover the opportunities and introduce the product (Crick and Spence 2005). An entrepreneur having a more extensive network will obtain more opportunities than the one who has a less extensive network. Networks also accelerate internationalisation by complementing resources of other ventures either large or small at different stages in the value chain (Jones 1999).

Background to the study

The above review of the importance of networking and internationalisation on the development of technology-based firms, led us to explore the attitude of the high-technology entrepreneur towards these issues. Are they aware that networks and networking are powerful instruments for growth of the firm besides the competitive advantage based on their advanced technology and do they act positively to nurture their networks? Are they conscious that internationalisation is a do-able option for even small firms and as a consequence are they thinking and acting globally?

In order to examine these issues, research was conducted in the context of Manchester Science Enterprise Centre (MSEC), which offers the postgraduate Master of Enterprise (MEnt) degree programme ‘designed to train and motivate, mentor and inspire entrepreneurs’ (MSEC 2005). In the first three years of the programme more than a third of the 78 students graduating had set up their own business (Smith 2004). A study of these knowledge-based entrepreneurs is considered useful, they are highly-educated with science and technology backgrounds and they have been on a programme which has developed their entrepreneurial and business skills whilst working on a project idea that has the potential for commercialisation. They are people stimulated by the standard educational route and serve as the entrepreneurial basis for economic regeneration and growth.
Methodology

The research adopted a qualitative case study approach and utilised an in-depth, semi-structured questionnaire completed in a face-to-face interview lasting about one hour. Triangulation was achieved with secondary sources and observation. The subjects were all graduates of the MSEC MEnt programme, selected by purposive sampling (Neuman, 2003). Six individuals were selected, each in a different stage of business. Among them, four have created their technology-based firms but each is at a different stage of his business. Although the other two have not set up their business at present with one pursuing a PhD degree and the other working as a key employee in a technology-based enterprise, both of them expressed their willingness to set up their own businesses in the future.

This study focuses on data collected on networking and global awareness though the questionnaire covered a number of additional aspects such as background, work experience prior to the MEnt, role models, personality, family upbringing, influences and motivation etc.

Interviews were fully transcribed and content analysis performed according to the method of Gillham (2000).

The questionnaire

The questionnaire explored the subject’s perception and attitude towards networks and networking’s contribution to business success, and then via small-firms network theory, this was compared to the individual’s network as well as measuring it according to the morphological and interaction dimension of social networks (Shaw and Conway, 2000). Finally, the interviewer tried to verify the practical effects of networks and networking on the growth of the venture by asking if the interviewee had received any help from his/her network when faced with critical incidents.

Harper and Previts (2002) proposed that a good way to obtain an understanding of interactions between countries, both politically and economically, was exposure to mainstream newspapers and publications. The interview therefore included questions on the reading patterns of the subjects. They were asked what sources they used and what information they were seeking. Subjects were also asked about their plans for international expansion and any strategies developed for this.
Findings

Perception and attitude towards networks

Five of the interviewees agreed that there is strong connection between the network and business growth. It is interesting to note a relationship between the degree of the positive attitude towards network and the scope of networks. Those who reported their belief in the link to be ‘very strong’ also self-evaluated their networks scope as ‘quite large’. The subject who reported his networks as ‘small’ believed the connection to be ‘fairly strong, not very strong’. Networks appear to be valued more by people who have more networks resource.

The interviews highlight that the perceptions of the young entrepreneurs towards networks as an important tool highly influenced the degree of networking, which support the proposition of Burt et al. (1998, Cited by Neergaard 2005).

As regards the purpose of networking, four individuals ranked ‘Make contacts that will help me in my career/business’ as the primary function of networking, which indicates an intention to develop useful contacts through established connections. A fully-utilised network does not imply only using the existing network, but continuously investing in the network to expand new connections. In this sense, it is a process of constantly creating new networks with the entrepreneur as the hub.

When assessed in terms of time invested in developing new contacts, size of network and time for travelling to meet and develop networks, these YTBEs are not the ambitious networkers expected. Only one out of the six cases spent more than five hours a week developing new contacts. Five respondents reported that more than 75% people of their primary network are reachable within one hour’s drive by car. Half of these entrepreneurs developed more than 50% of their contacts on their own initiative while the other half was passive and let the other party approach them. Although the majority reported that they perceived the strong relationship between network and the development of the ventures, they did not invest much in network developing. When talking about the contact initiative, the following comment was made:

“Nobody would want to make contact with me because I am quite low down in the hierarchy at the moment I think. So who is going to make contact with me? I am going to have to go out and find them.”

Research has tried to link a good performer in creating and maintaining complex networks with whether an individual is introvert or extrovert (Van de Ven et al. 1984). The data showed no clear pattern to link with their network performances.

Results show that five of the interviewees show a tendency to use their primary network actively and spend most of their networking time on this personal network. Three cases
reported they spent most of their time on personal network and the other two on complex network- a combination of both personal network and business network. It shows that personal network is still dominating, facilitated by strong ties supporting Birley et al.(1991:59) who remarked that ‘entrepreneurs, at an early age of enterprise development, rely heavily on an informal network of friends, family members and social contacts from the local neighborhood to gather relevant data. At a later stage, entrepreneurs rely increasingly on professional bankers, accounts, lawyers, suppliers, government agencies etc. to gain access to requisite business information.’

The network of the YTBEs was diverse in its range as four of them reported their networks were a mixture of well acquainted and not-well acquainted members while one stated that members were not well acquainted in her networks. This suggests that they establish separate networks to meet different needs. The more diverse the range of their entrepreneurial network, the more opportunities they have to acquire a variety of information, advice and resources from their social network (Shaw and Conway 2000).

Network in use

When the interviewees were asked to identify the most important business information sources, it was interesting to find they all ranked other business owners as one of three most important information sources. In fact, four of them ranked it as the most important one. Contrary to the study conducted by Chell (2000) on small enterprises in the UK, which revealed that overall 71% of her sample regarded customers as the most important source, only two of the YTBEs mentioned customers in the highest three rankings and neither of them ranked it as the most important one.

The data suggest that YTBEs cooperate in a mutually beneficial way and furthermore, the high ranking also suggests that the links among these YTBEs are very strong, quite distinct from the harsh and cut throat image of business competition.

“If anything comes up that I see will be potential business for somebody I know from MSEC …use AOL Instant Messenger or MSN Messenger … I will let them know and they will do the same for me. We do that…”

It is not competition that emerges here but the collaborative advantage of a high technology cluster. It appears that the MEEnt is more than a degree. To a certain extent, it is a network with ‘extras’.

The research also suggests that the young entrepreneurs enhance their access to more information from the social capital accumulated both horizontally and vertically from their fellow entrepreneurs and supervisors. The social capital the young entrepreneurs gained from MSEC already show the possibility to be converted into important and tangible benefits with the potential to grow into business opportunity. Recent findings demonstrate that a high level
of social capital which is based on networks, status and direct personal contacts contributes to the success of entrepreneurs by gaining access to potential customers and venture capitalists and others (Baron & Markman 2000; 2003). Thus social capital pulls in the resources needed for the further development of the enterprises.

Last but not least, the results find that all had contacted two or three support organizations in the past three years. This suggests an awareness of these ‘catalyst’ organizations and the active participation in utilising formal, institutional support networks. It is interesting to see that all six case have contacted the Department of Trade and Industry (DTI) and four of them have received DTI related funding or grants. Professional or Trade association were also exploited by four individuals. It might be a trait for technology-based entrepreneurs to maintain their technology edge and update information in their business sectors.

**MSEC as a networking platform**

Networks are intangible and difficult to demonstrate methodologically (Chell 2000). Yet no one will deny their presence. Just as the proposition by Myint et al.(2005) that the dynamic environments built by entrepreneurs is in fact the real sense of ‘incubator’ and it is this which adds value to a ‘physical incubator’, MSEC presents a similar networking platform for its students, the YTBEs.

When asked whether the University/MSEC is a good platform for networking, all interviewees replied without hesitation:

‘Definitely’

‘Very good’

‘Great yes’

‘Yes, I think so’

‘Yes, definitely’

‘Yes, definitely’

It reveals a high degree of approval of the networking function of MSEC. The nuance and context-rich accounts given by the young entrepreneurs may provide better insights:

“It is a good form of networking… in terms of business and getting funding and things like that it is good definitely. And the students, that is one of the most important things because you get all these young up and coming entrepreneurs that you are just mates with so that has got to be good…”

“I think one of the main things is the kind of network that you get from, as you say, from building relationships with people but the other network you get is from doing the course and you get to know a lot of people and there are a lot of resources and networks and that sort of thing…”
Reflection on Networking

The comments above reveal MSEC is not only about physical facilities, but is a technology start-up facilitator, an educator and an encourager of business development in terms of bringing together financial resources, human capital and an information exchange centre. Is it a coincidence that all six cases in this study had approached the DTI regarding grants and support? Or is it because of the extensive information sharing in the Centre’s Business Creation Unit, full of like-minded YTBEs. MSEC might also serve as a positive driving force for young entrepreneurs to engage in necessary networking activities which are widely regarded as one of the weakest aspects of young entrepreneurs.

In an entrepreneurial age where people are more important than the business idea itself, networks are intangible assets to an entrepreneur’s success. Hence, the continuous nurturing of the networks founded by MEEnt students is a crucial way to maintain the success of the dynamic MSEC high-tech cluster, and more importantly, ensure the future success of these YTBEs with the exchange of resources, information and opportunities within these networks.

Global awareness

Czinkota (1991) made the point that the awareness of crucial macro and micro information from around world was essential for firms to maintain a competitive edge in the global market. An analysis of international market failures disclosed that had firms and decision-maker in the firms acquired adequate information first, most errors could have been avoided (Ricks 1999, cited in Czinkota, 2000). An exposure to mainstream newspapers and publication is a good way to obtain an understanding of interactions between countries on both the political and economic fronts.

Although these young entrepreneurs read newspapers (or online news) frequently - five read newspapers everyday - their consciousness to seeking macro and micro information both at home and abroad, is weak. When asked what kind of information they are seeking, only three mentioned that they look at political and financial news in the UK and around the world. Only two browse the Financial Times, which is widely accepted as providing important financial and business information for the success of a business. One however responded:

“(I look for) things that will affect the finances of my business, so changes in government laws or whatever or the investments.”

Keeping a close watch on the frequent changes within the political and business environment at home and aboard, is a way to monitor global trends and as a result, entrepreneurs could respond to the opportunities emerging quickly as well as avoid any risks.

Almost everyone read the Guardian and at least one professional journal or industrial publication related to their areas regularly, which shows a strong motivation to maintain their technological edge and to protect against technology obsolescence.
Global expansion and strategy

All of the five entrepreneurs whose business is currently in operation, reported to have thought of global expansion but none of them possessed strategies to take the idea further. One entrepreneur, whose business was UK-based, disclosed that the reason he had looked at global markets was that it was a part of the business plan to attract government funding. Hence, ‘it wasn’t a business decision in terms of commercial need but rather it allowed access to funding’.

However, one case shows signs of the initial stages of internationalisation:

“We look at the worldwide market as an opportunity for us to either source funding or source academic or technological advice and help or source specific parts...if you don’t know what you are trying to sell inside out then you can’t do the best job...to do that you need to spend a significant amount of time out there (Israel) working with the technology to ensure that you understand it as best as is possible (in order to link up the requirements in UK and that in Israel).”

The company has a local representative in the USA, who has expertise in the field of the company’s business. They also visit international conferences to establish contacts, illustrating how networking facilitates the small firms’ internationalisation.

Reflection on global awareness

A firm’s internationalisation does not happen overnight, it grows from global awareness. Preparations need to be carried out and both financial and human resources need to be in the right place to enable opportunities to be pursued. Therefore, a global perspective should be adopted in the early life of SMEs, especially high-tech small firms.

One might argue that it is too early for the YTBEs to consider their firm’s internationalisation as the oldest among them is no more than two years old. It is not a matter of internationalisation or not, at this stage of the firm’s life, but to try to demonstrate the importance of being aware of the global interactions on the development of technological SMEs.

In order for YTBEs to develop more global awareness they should target international customers and cultivate global networks by attendance at international conferences. They should also develop a habit of exposure to up-to-date international news in the reading sections of key newspapers. It is an efficient way to gain insight into the dynamic economic relationships between countries.
Conclusion and Recommendations

The empirical results have significant policy implications for supporting the development of the high-technology SME sector and providing insights into the internationalisation of high-technology SMEs. The research finds that the YTBEs in this study show highly positive perception towards networks. They utilise the social networks established through MSEC; they show advantages of being part of a high-tech cluster and they actively engage in the networks of support organisations.

Networks is not a particularly self-reliable item, that is its development is significantly influenced by a number of factors such as the experience and career background of the entrepreneur and the education level of the entrepreneurs (Shaw and Conway 2000). An individual’s ‘know-who’ is closely associated with who he/she is. Hence, although there is not sufficient evidence to demonstrate that the MEnt course has formed the networking perceptions and behaviours of these entrepreneurs, its influence is undoubted. MSEC is a good network platform to facilitate the development of their business. Policy-makers should be encouraged to nurture and further develop this human-based incubator model.

As for the investigation on the global awareness of the young entrepreneurs, it shows less optimistic results than that on networking. They pay some attention to foreign issues but appear indifferent to the global context. None of them have a strategy for internationalisation.

There are of course limitations in this research and some of the measurements are based on the subjective answers of the interviewees, which might undermine the quality of the evidence. However, this qualitative study has elicited some themes which deserve further investigation and explanation. A study with quantitative methods might demonstrate the extent of these tendencies. Furthermore, a horizontal study comparing this study with data on other entrepreneurship education programmes might yield valuable learning points.


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Efthymios Constantinides  
Assistant Professor  
Faculty of Business, Public Administration and Technology  
University of Twente,  
P.O. Box 217  
7500 AE Enschede  
The Netherlands  
Tel +31 53 4893799  
Fax +31 53 4892159  
Email: e.constantinides@utwente.nl
The importance of Internet as a strategic management tool:
A study of Dutch SMEs

Abstract

This paper proposes a methodology for the identification and evaluation of Internet-based strategies and examines the role of the Internet as element of the strategic planning of Small and Medium Enterprises (SMEs) from a variety of Dutch industrial sectors. The study has an explorative character and is based on empirical data; it reveals the degree of acceptance and integration of the Web into the strategic plans by assessing management attitudes in three categories of factors delineating the online strategy. The findings suggest that while managers appreciate the importance of the Internet as essential component of their business setting, Web-based commerce does not seem to have become an integral part of corporate strategy by this category of businesses; limited strategic commitment and cautious attitudes in adopting technology as an important strategic option are for all intents and purposes preventing SMEs from fully utilizing the potential of the virtual marketplace.

Key words:
Internet Strategy, Strategic Planning, E-Business, E-Commerce, SME strategies

Internet and E-Commerce

Having survived the deep crisis that followed the commercially unsustainable Internet boom of the 90s, the Web–based commerce, better known as E-Commerce, has evolved from a technological oddity and source of media thrill to a mainstream business activity; after only 10 years of commercial presence the Internet technology seems to enter its maturity stage as a business setting and social phenomenon and only a tiny majority of business in the western world does not have some kind of presence online. The term E-Commerce (EC) has been around for more than two decades. During the 80’s EC was beyond the reach of the wider public, it was a set of proprietary business-to-business Information and Communication Technologies associated with the Electronic Data Interchange (EDI) and Electronic Fund Transfers (EFT) (Oz, 2002). In that respect most
academics and practitioners would refer to E-commerce in the pre-Internet era as a collection of ICT-enabled proprietary technologies meant to increase operational efficiency in B2B transactions through transfer of commercial information and funds in inter-organizational transactions. A common idea evident in the literature of the 80s and beginning of the 90s was that EC was primarily a technical issue where information technologies and supply chain efficiency rather than marketing issues were involved.

While the EDI/EFT – originating definition of EC has not completely disappeared from the present-day literature\(^1\) the majority of academics and practitioners today do not anymore define EC in EDI terms (Rayport and Jaworski, 2004; Fletcher et al., 2004) while the majority of definitions either link it to transactions conducted over computer networks (Turban et al., 2004) or to Internet-mediated transactions in particular (Oz, 2002; Siegel, 2004; Awad, 2004; Tapp A., Hughes T., 2004). A broad definition of E-Commerce should not however be limited to Internet-enabled transactions since transactions form merely a fraction of the commercial activities taking place online. In that sense E-Commerce can be defined as a collection of Web-based technologies, tools and business processes improving, supporting, supplementing or replacing traditional commercial (and non-commercial) practices.

On the basis of the above definition two remarks are in place:

1. E-Commerce is part of a variety of corporate activities collectively labeled as E-Business. While no definition of E-Business has been broadly accepted and in many case this term simply refers to Internet Marketing (Amit and Zott, 2001) one could identify as E-Business the collection of various organizational processes facilitated by means of Information and Communication Technologies: document management, Efficient Resource Planning (ERP), knowledge creation and knowledge sharing, computer-mediated communication, employee services, Supply Chain Management (SCM) and other (Illustration 1).

2. The “traditional practices” mentioned in the definition are practices like marketing, logistics, procurement or financial transactions to name the most important ones. On the basis of the above definition of Ecommerce one could argue that EC is nothing essentially new as to its substance; the new element is that the existing, traditional practices can be carried out

\(^1\) Definition 1: E-Commerce: Any on-line transaction of buying and selling where business is done via Electronic Data Interchange (EDI) from: WorldNet Daily, 2005.

Definition 2: E-Commerce: The process of putting the pieces together for electronic commerce. It includes, for example, buying and selling products with digital cash and via Electronic Data Interchange (EDI). Bitpipe.com, 2005
faster, more efficiently, cheaper and sometimes in a totally different manner by means of Internet-based technologies. Therefore E-Marketing is one of E-Commerce dimensions or functions; other such functions are E-Procurement, E-Logistics, E-Finance etc. (Illustration 1).

Compared to the traditional business procedures, the Web enabled practices give E-Commerce some exceptional strengths and characteristics. As the most common of them we can mention the 24 hours, 7 days availability, the theoretical reach of global markets - markets much larger and diverse that any high-street retailer or brick-and mortar traditional business can reach - the lack of physical contact between transacting parties, new forms of distribution, the availability of many new media forms, the dynamic pricing and the online transactions. The web has placed new powers at the hand of the consumer and Internet based marketing activities grow exponentially, often at the cost of traditional Marketing channels (Urban, 2004).
The significance of E-Commerce as element of company strategy

The excitement around the first generation of Internet start-ups during the 90’s combined with unrealistic assumptions as to their commercial value and potential lead to the Internet bubble that resulted in a disastrous industry collapse around the spring of 2000 (Thornton J., Marche S., 2003); the high tech melt-down sparked a chain reaction that affected not only the dot.coms or the ICT business but the world financial markets and world economy in general. The aftermath of the high-tech fall-out brought a sense of disillusionment or even resentment towards E-Commerce in corporate as well as academic circles for some time. There is however evidence that the scholarly and public perception as to the strategic role of the Internet is positively changing again while several indications suggest that the networked economy has entered a more mature stage of its life cycle. Boosted by increasingly affordable, faster connectivity the number of online consumers is expected to exceed the 1 billion in 2005, according to the Computer Industry Almanac (from only 15 million in 1995), the number of web host servers has reached the 318 million in 2005 (from 6 million In 1995) and some studies suggest that 10% of the total retailing will take place online in 2010 (Forrester Research, 2004). Next to that observers often underline the growing importance and role of the web as a marketing instrument by looking to the growth of budgets spend on Internet-based marketing activities as a percentage of the total marketing expenditures. Another fact underlining the general attitudes and optimism is the performance of high-tech equities; the current valuations of established Internet stocks, although still very far from the highs of the Internet bubble, indicate a healthy recovery while successful IPOs of virtual corporations begin to make headlines again.

The conditions however today have very little in common with the conditions of the 90s. The Internet of 2005 is technologically in a much better shape and more embedded as a mainstream commercial activity than it was in the year 2000. The web has been adopted by most business not only as an alternative communication or distribution channel but also as an essential commercial tool additional of complementary to traditional marketing practices. Next to the acceptance of the importance of the Internet by the vast majority of traditional businesses there are also many notable examples of businesses successfully and profitably operating exclusively or almost exclusively online.

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2 Web marketing spending is forecasted to reach the one tenth of the total marketing expenditure of one trillion $US of 2005. (Blackfriars Communications, 2005)
Some other developments further underline the importance of the web as a commercial environment; the virtual consumer’s demographics have changed and wide population segments including almost all age categories, races and genders make the ever-growing population of Web users. The Internet is by now the third largest distribution channel in the western markets while online retailing operations keep growing in sales, average ticket and conversion rates (Internet Retailer, 2005). For all intents and purposes the Internet has become the main source of market information for hundreds of million of consumers (Urban, 2004) and an important influencing parameter of consumer behavior and choice (Sharma and Sheth, 2002; Constantinides, 2004; Urban 2004). In this sense it is not surprising that many businesses are increasingly using web-based analytic tools for tracking and analyzing consumer behavior not only online but also across channels (Forrester Research, 2005). Furthermore affordable broadband connectivity has immensely increased the technical and marketing capabilities of the Internet and young population segments having grown with the Web as integral part of their learning and social environment enter the market as consumers, employees and managers.

The undisputed success of some of the old generation Internet companies (Amazon, Priceline, Yahoo, CNET, Expedia etc) as well as some new of the new entrants (Ebay, Google, Skype etc) have also boosted the image of the Internet as a dynamic commercial platform encouraging or even compelling CEOs to rethink their strategies and the potential role of the Internet as strategic element. (Rowley, 2002).

**Strategy and E-Strategy**

In this background several academics and practitioners have pointed to the importance of the Web as a new organizational and strategic parameter and have frequently underlined the main issues arising from the adoption of E-Commerce as a strategic choice (Kraemer and Dedrick, 2001; Sharma and Sheth, 2002; Gunasekaran et al., 2002; Awad, 2002; Pires and Aisbett, 2003; Rowley, 2002). However academic research on the actual adoption of web as a fundamental part of the corporate strategy by commercial organizations is limited and fragmented. Researchers usually focus on the more general issue of adoption of Information and Communication Technologies by firms, often from the innovation adoption perspective as van der Veen (2005) notes in her comprehensive work in this field; this researcher, based on the Dutch experience, identified a number of firm characteristics explaining the e-business adoption and concluded that that “in general small and medium size enterprises lag behind
larger companies when it comes to benefiting from the integration of ICTs into their daily business”.

This study attempts to contribute some further insight on the issue by examining the degree of adoption of the Internet as element of firm strategy by small and medium-sized businesses (SMEs). The approach is based on the evaluation of corporate attitudes in a number of E-Commerce critical strategic issues identified in the Web-Marketing Mix model (Constantinides, 2002).

The Web Marketing Mix (or 4S Model) describes the four critical elements of the online marketing as a managerial process (Illustration 2) underlining the importance of a comprehensive and multi-dimensional approach to E-Marketing. Unlike the 4P Marketing Mix (and its several variants) the traditional marketing toolkit (Borden, 1964; McCarthy, 1964) emphasizing tactical and operational factors as the critical aspects of the marketing process (Jobber, 2001; Kotler, 2003 Kumar, 2004), the Web Marketing Mix identifies a combination of strategic, operational, organizational and technological parameters as the essential factors of E-Marketing.

**Methodology**

The empirical data for this study has been collected by means of a survey carried out by in the context of a student assignment in a Technical University in The Netherlands. The first stage of the project was the identification of parameters indicative of the strategic integration of the Internet into the corporate strategy. After evaluating several options the group decided that the 4S Web Marketing Mix framework (Constantinides, 2002) identifies several such parameters and therefore presents a good reference basis for constructing a questionnaire. As expected the majority of parameters relevant to corporate strategic attitudes were found in the predominantly strategic elements of the 4S framework namely the Scope and Synergy factors. However the Site element of the model, while dealing primarily with tactical and operational aspects of the Web marketing, yielded also a number of parameters of strategic importance³. The questionnaire was divided in three groups of questions according to the question origin in the 4S framework and the results were processed with the statistical program SPSS.

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³ The System factors were not considered as relevant in this study due to their primarily technical character
1. Scope: Strategy and Objectives

**Market Analysis:** Competition basis, competitors, market potential, market forecast, market trends

**Potential Customers:** Profiles, motivation, behaviour, needs and current way of fulfilling them, priorities

**Internal Analysis:** Internal resources, processes, values. Is the Web a sustaining or disruptive technology?

**Strategic Role of the Web Activities:** Generic types: Informational, Educational, Relational, Promotional, Transactional

2. Site: Web Experience

Customer oriented content. Important questions:
- **What does the customer expect in the site?**
  Domain name, content, design, layout, atmosphere, aesthetics and web site positioning and the classic 4 Ps
- **Why the customer will make use of the site?**
  Simplicity, functionality, speed, findability, searchability, navigation, interactivity and customisation
- **What motivates customers to come back?**
  Online service, customer feedback, Relationship Management, Information quality and "freshness"
  Customer protection, privacy policy, perceived security

3. Synergy: Integration

**Front Office integration:** Integration with the physical Marketing Strategy and Marketing Activities

**Back Office integration:** Integration of the Web site with Organisational processes, Legacy systems and Databases

**Third Party integration:** Create networks of partners who will assist the commercial, logistic and other site activities

4. System: Technology, Technical Requirements and Web Site Administration

Software, hardware, communication protocols, content management, system service, site administration, hosting decisions, payment systems, performance analysis

Illustration 2: The Web-Marketing Mix (Constantinides, 2002)
The strategic issues that formed the basis for the questionnaire were chosen from a list illustrated in Table 1.

PART 1: SCOPE (Strategy)

*Competition*
- Knowledge competitors
- Ahead of competitors

*Customer*
- Knowledge of customer profile
- Knowledge of customer objectives
- Monitoring online customer behavior

*Strategic role*
- Extra revenue
- Branding
- Relation marketing
- Find new markets
- Stay ahead of competition
- Positive customer image
- Product information
- Promotion
- Other
- E-Commerce important for Long Term Plans

*Importance of Following Developments E-Commerce*
- Yes
- No
- Neutral

*Main Information Sources*
- Trade fairs
- Specialized press
- It Specialists
- Own Research

PART 2: SITE (Online experience)

*Site updates*
- Daily
- Weekly
- Monthly
- Yearly
- Never

*Response to emails*
- Within 24 hours
- Within 2 days
- Within 1 week

*Customer service*
- Online complains/questions total
- Service point
- E-mail / telephone
- Via web site
PART3: SYNERGY
(Organizational integration)

Back Office
Person responsible for E-Commerce
Influence on Business Processes

Front Office
Marketing Budget
Internet budget

Third parties
Online advertisement
Online Links
Online banners

Table 1. Indicators of strategic integration of E-Commerce in the corporate strategy per S-factor

The survey aimed at assessing managerial perceptions as to the importance of the Internet as an element of corporate strategy and managerial attitudes as to the degree of integration of the online business into the corporate strategic plan. The questionnaire was consisted by 39 questions, the majority of them being 5-scale evaluating questions (Likert type 5-scale ratings - 1: totally disagree, 5 totally agree) and agree-disagree type evaluating statements.

Two hundred thirty-one (231) companies from ten different industries were randomly selected from the Dutch Yellow Pages (Graph 1). All companies have a corporate web site as well as physical commercial presence.

The survey was carried out by phone; the executive responsible for the company strategy was contacted and asked to fill in the questionnaire that was available online. The data was directly forwarded to a database for further processing with in SPSS. Some participants expressed the preference to fill-in the questionnaire by phone, this option was also available. The survey yielded was 70 fully completed questionnaires.

Results

A. Participants’ profile

I. Sectors and response. The branch and the number of SMEs that participated in the survey per industrial sector is the following is illustrated in Graphic 1
All participating firms were small or medium size enterprises with both physical and online presence. The majority (58.6%) were enterprises with less than 10 personnel. Companies with up to 50 employees made up 94.3% of the sample, corresponding to the average percentage of European SMEs with less than 50 employees (95%) found in a study of E-business Indicators (2005)\(^4\). The exact composition of the sample is illustrated in Table 2.

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>41</td>
<td>58.6</td>
</tr>
<tr>
<td>10 – 50</td>
<td>25</td>
<td>35.7</td>
</tr>
<tr>
<td>50 - 250</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>&gt; 250</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>70</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 2: Number of personnel of participating companies

II. Years of online presence. The majority of the participating companies entered the web between 1997 and 2003. (Graph 2).

\(^4\) Study: A portrait of e-business in 10 sectors of the EU economy, 2005 edition
The Internet melt-down of the year 2000 does not seem to have essentially affected the number of businesses going online but after 2003 the number of new entries is reduced. Since the Internet penetration of businesses in The Netherlands is quite high the graph can be indicative of the fact that the Internet technology has been adopted by the majority of Dutch SMEs. This is also obvious if we observe the obvious similarity between the shape of the graph and the shape of the well-known innovation adoption curve of E. Rogers (1976); such a comparison indicates that the bulk of potential users (the categories of Early and Late Majority in Rogers terms) has by now joined the ranks of virtual commerce community.

**B. Survey findings**

The questionnaire opened with a few general questions mean to identify the management attitudes with regard to the issue of strategy; they were asked whether their company had long-term strategies in place and if so whether they consider the Web as an important parameter of their long-term strategy.

Regarding the question about having a corporate strategy in general, 43 (61%) of the 70 firms confirmed having indeed a long-term strategy in place; these firms were asked how important they consider the Internet as element of their strategy. The average score 4.09 indicates that
the majority of managers recognizes the importance of the web as a strategic factor however the score was lower (3,72) when they were asked about the importance they believe the Internet plays in their own corporate strategy. (Table 3).

<table>
<thead>
<tr>
<th>Importance of the Internet for Strategy</th>
<th>Weight of the internet in your company’s Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid N</td>
<td>43</td>
</tr>
<tr>
<td>Minimum</td>
<td>2,00</td>
</tr>
<tr>
<td>Maximum</td>
<td>5,00</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>4,09</strong></td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>1,06</td>
</tr>
<tr>
<td></td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>1,00</td>
</tr>
<tr>
<td></td>
<td>5,00</td>
</tr>
<tr>
<td></td>
<td><strong>3,72</strong></td>
</tr>
<tr>
<td></td>
<td>1,18</td>
</tr>
</tbody>
</table>

Table 3. Importance and weight of the Web for long-term strategy (5: Very important, 1 Very unimportant)

With regard to the strategic aspects identified in the three S-criteria (Scope, Site and Synergy) of the Web-Marketing Mix the outcomes of the survey are the following:

**I. Scope**

The scope dimension describes the basic strategic issues underpinning a powerful and successful online presence; companies regarding E-Commerce as important part of their strategy have to address these issues in a comprehensive and consistent manner.

The attitudes of the participating companies in the Scope aspects were evaluated in three categories of criteria:

1. Knowledge of the competition and competitive environment
2. Knowledge of the online customer and customer needs
3. Strategic role of online presence

In detail:

*1. Knowledge of the competition and competitive environment*

The participants were asked to evaluate the extent of their knowledge about online competitors and online competitors’ strategies as well as evaluate their own position as Internet player versus the competition, i.e. whether they consider their online presence as a leading one in their market. The results are illustrated in Graph 3.
The knowledge about online competitive conditions is somewhat positive (average 3.6) indicating that the companies consider themselves having some knowledge about their online competitors and their strategy; the response to the question as to their position as leaders in their online market (2.9) indicating a cautious approach and lack of proactive attitude.

2. Knowledge of the online customer and customer needs

Knowledge about the profile of customers visiting the company web site as well as intelligence about the virtual customer’s needs or motives are important inputs in designing a web site delivering the proper online experience and meeting the customer’s expectations. Acquiring such inputs requires a consistent strategy and managerial commitment.

In Graph 4 we see that the average scores regarding the knowledge about online customer’s needs (3.7) and the knowledge of the online customer profile (3.0) are relatively low, indicating that little effort is done in actively pursuing market intelligence or that little effort is put on using existing intelligence.
In order to obtain more feedback as to the source of the available knowledge on customer needs and customer profiles the participants were asked to indicate whether they monitor their customers’ online behavior when visiting their web site. From the 70 participants in the survey only 20 (28.5%) are somehow following and registering customer online activity while 13 (65%) of them simply registering the number of hits to their web site. Usage of advance software tools like Opentracker, MetrixLab and ExtremeTracking that can register online behavior of customers, is sporadic.

The high percentage of companies that do not take any action in tracking and analyzing the behavior of their online customers explains the limited expend of customer knowledge. This could mean that the large majority of these firms make decisions about their online presence without enough background on the customer’s needs and behavior or base their Internet approach on customer information originating from their physical business channel.

3. Strategic role of online presence

A Web site can fulfill different generic roles as a strategic instrument; such roles can be informational, promotional, relational, transactional, educational etc. In practice the majority of online business models fulfill a combination of these roles depending on the type of the firm, the strategic objectives and the mission the company assigns to its online presence (Constantinides, 2002).

Survey participants were asked whether they have assigned clear strategic objectives to their web venture and if so what the nature of these is (Graph 5). Participants could chose from a

Graph 4. Knowledge of customer needs and profiles, mean values (max value 5)
list of such objectives and indicate in the 1 to 5 scale their importance (more than one of such objectives could be identified).

![Graph 5: Main strategic objectives of web sites](image)

Legend
1: Transactions, 2: Increase of brand awareness, 3: Improvement of customer relations/retention, 4: Expanding market coverage, 5: Obtaining/maintaining competitive advantages, 6: Improve company image, 7: Informational purposes, 8: Promotional purposes

Evidently the major objective pursued by the online presence is improving the company image (objective nr. 6) followed by promotional purposes (objective nr. 8) and increasing of brand awareness (objective nr. 2). While the transactional objective seems to be reasonably important for many participants, it is interesting that the three main purposes are actually having a communicational rather than transactional character; this could indicate that the online presence is primarily seen as an important element of the communication mix rather than an adult distribution channel. Objectives capitalizing on the interactive, global and individual character of the Internet like retaining customers and expanding the market coverage are considered as less important, without however scoring below the mean value.
II. Site (or online customer experience)

Factors underpinning and enhancing the customer online experience are mostly of operational rather than of strategic nature (Constantinides, 2002). There are though elements related to the web customer experience that can be indicative of the strategic attitudes of Internet firms. In that sense the survey was focused on three issues having a clearly strategic dimension since these require a long-term vision, commitment and allocation of resources:
1. the web site updating policies i.e. the frequency of updating the online content
2. the attitudes towards providing online customer support
3. the policies as to improvement of customer experience and web site interactivity by integrating new technology tools and methods; the question was whether the SME’s participating in the survey were actively following the recent technological developments in the field.

1. Updating frequency

The updating frequency of a web site is one of the signs of the strategic responsiveness of organizations to environmental change (King and Liou, 2004). Furthermore frequent updates of the web site are indicative of the company’s commitment to present its web-site visitors an up-to-date content, making their web site attractive for business and encouraging repeated visits. The outcomes of the question “what is the update frequency of your web site?” are illustrated in Graph 6.
Graph 6: Frequency of Web site updates

The overall picture is positive considering that 54 companies (77%) update the content of their web site every month, almost half of them weekly or even daily; A limitation of the study is that it does not reveal very much about the nature and extent of content amendments or updates as well as about the motives for that; therefore this is an issue requiring further investigation.

2. Customer service online

Online customer service is a vital element of the web experience (Constantinides, 2004), reducing the threshold for online transactions and enhancing the web site’s credibility (Fogg te.al. 2002). Prompt and efficient handling of customer queries and effective customer support require investing in creation and maintenance of online customer service facilities. Such investment involves managerial commitment, allocation of resources and minor or major organizational adjustments.

Two aspects were identified as important criteria here: the firms’ attitudes as to responding to emails and the way of handling online customer complains or problems.

Response time to emails might appear as a relatively trivial issue yet it is generally considered as a cue for inferior customer management and is one of the main sources of frustration of Internet customers\(^5\). In practice many online organizations fail to deal properly with customer emails because they do not understand the importance of proper handling of emails or because they lack proper organizational structures. While this is one of the older problems of E-Commerce, the situation even in the year 2005 remains knotty with negative effects on online customer experience and customer relations in general.

The majority of the surveyed firms seem to understand the importance of a quick response to customer enquiries by email: 57 (82%) of them indicate that they respond within 24 hours to customer emails, 10 (14%) within two days and the rest within one week or longer. (Graph 7)

\(^5\) “Among North American SMEs with revenues of $10 million and $250 million, 51 percent failed to respond to emails at all and 70 percent did not respond within 24 hours, compared to 41 percent of enterprises not responding at all and 61 percent not responding within 24 hours”. Coreen Bailor, 2005, Destination CRM
The second issue examined is the attitudes towards online customer service. After-sales support or other types of customer services are often mentioned in the literature as important contributors to customer satisfaction (Novak et. Al., 2000; Wolfinbarger and Gilly, 2003). Managerial commitment in online customer service requires setting-up the online and back-office infrastructure. Firms lacking this infrastructure try to offer to Internet customers services (after-sales, support etc.) through existing traditional outlets or other communication channels like call-centers and email.

With regard to the channels used for handling customer problems or providing customer services, the survey revealed that 53 (83%) of the participating companies offer customer support services via telephone or email while only 12 (19%) offer help online; only 7 (11%) of firms saying to offer online customer service actually have also a Web service department dedicated to online customer support. (Graph 8).
3. Technological updates

A third aspect indicative of the strategic commitment to providing a compelling online experience is the attitude as to tracking change and innovation around the web technologies. Having a system or mechanism for following technological change in place is important for continuously improving the online experience and operations, as a means for sustaining online competitive advantages. The participating firms were asked to indicate how important they consider to follow technology trends and developments in the field of the Internet. 26 firms (37%) found it important or very important, 23 firms (33%) found it unimportant or very unimportant and 21 firms (30%) were neutral as to the importance of tracking technological trends. (Graph 9)
The firms were also asked what their main sources of information about Internet trends and technologies are. The most frequent answers were: IT specialists, the specialized press and periodicals, in-house research and trade fairs. The results are illustrated in Graph 10.

![Graph 10: Most common sources of Internet trends and technology developments](image)

### III. Synergy

The factor Synergy in the 4S Web Marketing Mix model defines three main areas of strategic organizational integration of the Internet activity: Front Office, Back Office and Network effects (Constantinides, 2002)

With regard to the Front Office Integration (i.e. to what degree the online commercial activities are part of the total marketing plan of the organization) the basic strategic indicator was the availability of a budget dedicated to E-Commerce activities. A common problem of the smaller SMEs is that they do not always allocate any funds to Marketing on the first place. With this in mind the firms that had Marketing budgets were further asked whether any part of this budget was available to E-Marketing activities this year. From 69 companies that responded to this question only 34 (49%) had a marketing budget and 25 of them (74%) allocate part of this budget to online activities. Therefore only 36% of all firms in the sample population have actually a budget for online marketing. The low percentage of firms allocating funds to their online activities is an issue of concern since it is at odds with the
explicit interest of the majority of these firms for the internet and their intention to pursue their online endeavors.

The Back Office Synergy refers to the degree of strategic integration of the online operation into the organizational body, legacy systems and value-adding activities (Constantinides, 2002). Such integration is likely to affect internal procedures, communication lines, functions and business processes, something requiring a re-evaluation of the internal value-delivering system and often some degree of re-engineering of internal processes.

In order to identify the degree of strategic integration of E-Commerce activities into the organizational body the firms were asked whether the online activities have affected their internal operations and if so what functions or value-adding processes were affected.

Responses to the first question reveal that only 26 firms (37%) consider that the Internet activities have affected their internal organization while 44 firms (63%) say that this has not been the case. The later can indicate that the online activities do not form an essential part of the corporate strategy of these firms or that they have not been sufficiently integrated the online with their back-office activities.

Firms considering that the Internet has affected their internal operations were asked to indicate in a scale between 1 and 5 the significance of the effects of the Internet on the different organizational functions. (Graph 8)

![Graph 8: Effects of Internet on Organizational functions (1: very unimportant, 5: Very important)](image)

As it is evident here, the primary value adding activities (Porter, 1980) of Marketing / Sales, Logistics and Production are considered as mostly affected; with the exception of Marketing / Sales the effects however on production and logistics are assessed as mild. The secondary
value-adding activities Human Resources and Management were also considered as influenced by the internet operations with management perceived as the most seriously affected area.

The third element of Synergy (integration with third parties or synergy effects) refers to a firm’s option to engage various online, network-based marketing tools or activities in supporting and promoting the corporate web site. From various options as to network-based marketing tools or activities the majority of the surveyed firms (41 firms or 59%) limit their actions on web links, 26 firms (37%) advertise online and 19 firms (27%) make use of click-through banners. Activities belonging to the area of affiliate marketing or search engine optimization do not make part of the network-based marketing tools of the surveyed firms.

Conclusions and discussion of the results

Conclusion 1: Scope
The strategic foundations of Dutch MSB web sites are not quite solid. While the firms surveyed seem to agree in general on the importance of the web as a strategic element for now and the future they seem to lack a clear picture on issues underpinning their online strategy; such issues are the customer behavior and market needs, competitive strategies and understanding of the market environment in general. This fact indicates a lack of serious commitment to invest in activities necessary for acquiring sufficient market knowledge necessary for obtaining competitive advantages and market leadership. The lack of strategic commitment is underlined further by the fact that the most important online objectives of the firms examines are of communicational and informational nature. Acquisition, online transactions, expansion in new markets and customer retention seem to have a lower priority as strategic online objectives.

Conclusion 2. Site
In the area of the strategic attitudes as to the online customer experience we can identify both positive and negative outcomes. The positive attitudes of the surveyed companies are the frequency of the web site updates and the importance attributed to quick response to online customer inquiries by the large majority of them. Also a relative high number of firms seem to agree on the importance of following the technological developments and trends in the online environment.
In line with this perception most firms score satisfactory only in the issues of frequently updating the content of their web presentation and responding quickly to customer emails. Yet most firms saw a poor record when it comes to online customer service infrastructure and their attitude towards innovation. With regard to customer service most of these firms are not investing in online customer support infrastructure, preferring to rely on traditional methods of customer support.

Finally in the issue of tapping and implementing innovation it seems that approximately 25% of the firms are not interested and have no procedures in place for tracking technological innovation while those actively following the technological change either by own research or by following the press and trade fairs are the minority, less than the half of the total population.

**Conclusion 3: Synergy**

The majority of the surveyed managers indicate that integration of E-Commerce activities into the corporate marketing and organizational strategies is far from complete. The low percentage of companies actually having a dedicated budget for their online operations is indicative of the limited synergies between traditional and virtual marketing. Furthermore the degree of integration of the E-Commerce activities into the organizational body seems to be low. The observed lack of strategic commitment by many firms is also reflected in the limited investment in effective yet costly online marketing activities with more emphasis on low cost yet less effective promotional tools.

These results indicate that while the general sentiment of Dutch SME managers about E-Commerce is positive and they consider the Internet an important field for business the actual attitude of most of these organizations is still cautious. This is particularly odd in a country with a very high Internet penetration⁶. As a result of that one can argue that the actual role of E-Commerce as a strategic factor is still limited. Lack of confidence, lack of knowledge or simply the fear of the unknown can be major impediments in this effort.

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⁶ 68.7% of the population uses the Internet in the Netherlands according to the Internet world Statistics, 2005 [www.internetworldstats.com/](http://www.internetworldstats.com/)
Limitations of the study and issues of further research

This study has an explorative character focused on a small segment of the Dutch SME business domain and attempting to test a fundamental methodology for analysis of the strategic attitudes of businesses towards E-Commerce. One of the basic weaknesses of the study is its geographical limitation meaning that one should be cautious with generalization of conclusions. A follow-up study could include more countries, more categories of companies and more industries and could become the basis for an industry benchmarking as a tool helping firms to identify weaknesses in their approach. Benchmarking could be also a sound basis for a study with a longitudinal character that will help understanding the dynamics and mechanisms of the Internet evolution as a corporate strategy tool.

Acknowledgments

The study is based on a survey conducted by a group of BA students of the BBT faculty of the University of Twente in the context of their BA Thesis under the supervision of the author and Dr. Peter Geurts. The contributing students are Gulcan Oztas, Erwin Bosman, Hans Kamping and Jordy Gierveld. Many thanks to them as well to Dr. Peter Geurts for his valuable advices and contribution to the project.

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Web Sites


On the Recognition of Venturing Opportunities in Science and Technology

William A. Lucas, Cambridge-Massachusetts Institute, MIT, 77 Massachusetts Avenue, Cambridge, MA., USA (walucas@mit.edu)

Sarah Y. Cooper, Hunter Centre for Entrepreneurship, University of Strathclyde, 26 Richmond Street, Glasgow, G1 1XH, Scotland (sarah.cooper@strath.ac.uk)

and

Elena M. Rodriguez-Falcon, Department of Mechanical Engineering, University of Sheffield, Mappin Street, Sheffield (e.m.rodriguez-falcon@sheffield.ac.uk)

Abstract
This paper seeks to understand the psychological mechanisms which support the recognition of science and technology-based opportunities for new ventures. Opportunity recognition is viewed as a critical skill in venturing activities, but there is doubt about the mechanisms involved. The entrepreneurship literature contains a tradition of seeing opportunity recognition as a less than conscious process, that starts with an “initial intuition,” and “involves a subconscious evaluation,” a view that suggests the psychological process of directed attention, where the direction for any given individual is a function of personal interests and experience. A small number of qualitative interviews at the University of Sheffield are first reported that support the finding that such a cognitive mechanism is present. Then a scale used to measure “attention to use” in a survey of 494 science and engineering students at four UK universities is presented, along with its correlation with venturing and applied technology self-efficacy. The conclusion addresses the implications of recognising directed attention as a major component of opportunity recognition.

Entrepreneurial opportunity recognition and directed attention to use of technology
This paper seeks to understand the psychological mechanisms which support entrepreneurial opportunity recognition. That recognition is treated here from the perspective of Kirzner’s (1979) entrepreneurial alertness, a perspective that calls attention to the unconscious processes of discovery. It begins with the proposition that a substantial fraction of opportunities recognised by nascent entrepreneurs are not conscious in the sense that they are not found through a process that is driven by rational search or even by the conscious focusing of one’s attention. A cognitive theory of unconscious recognition and discovery is considered that might then explain this phenomenon, based upon the proposition that individuals develop a directed attention through interest and experience to quite specific domains.

A summary review of the opportunity recognition literature is offered focusing on the psychology of the recognition process that often precedes conscious search for an idea. The probe into the nature of the opportunity recognition process among a small number of mechanical engineering undergraduates at the University of Sheffield is then offered to provide a qualitative test of the source of ideas, leading to the conclusion that some unconscious process of screening and evaluating ideas must be at work. The next section offers a discussion of the theory of directed attention as a basis for considering what processes might be at play. The methods and results section then provides the findings from a survey of 494 second, third and fourth year engineering undergraduates at the
Universities of Cambridge, Sheffield, Strathclyde and York. In the process a measure of Attention to Use of technology will be presented, along with measures of pre-entrepreneurial behaviour and entrepreneurial intent. Concluding comments will reflect on the role of university education in the development of unconscious attention.

Opportunity recognition and entrepreneurial alertness
The general view of entrepreneurship that underlies this research is offered by Bygrave and Hofer (1991) who suggest that entrepreneurial research would do well to begin with a definition that the, “entrepreneurial process involves all the functions, activities, and actions associated with the perceiving of opportunities and the creation of organisations to pursue them”. This definition has proven to be a useful starting point for others (Keh et al. 2002, Ucbasaran et al. 2001), perhaps because it anchors the study of entrepreneurship on a process concept. It also emphasises the role of perception, drawing attention to the cognitive mechanisms that the entrepreneur is said to employ, which may vary from stage to stage in that process. The concern here is the very first step, the recognition of opportunity, and the cognitive processes of entrepreneurial alertness that precede it. The premise is that opportunity recognition includes an unconscious process, in that it is not consciously directed and the individual is generally unaware of their state of alertness. The individual’s attention is directed by current interests and intent, and shaped by past personal experience and known information. In this research, the concern is identifying a cognitive process of directed search for new applications of technology for undergraduates studying science and engineering.

Entrepreneurial alertness as advanced by Kirzner (1979) would seem to be an instance of some general form of directed attention. He suggests that the entrepreneur plays a key role in reestablishing market equilibrium by the discovery and grasping of opportunities that others do not see without actually searching for them. “Entrepreneurial alertness consists, after all, in the ability to notice without search opportunities that have been hitherto overlooked” (Kirzner 1979, 148). It would seem that these discoveries are made through some process of unconscious recognition by agents who are “spontaneously on the lookout” for unnoticed features in the environment: “Without knowing what to look for, without deploying any deliberate search technique, the entrepreneur is at all times scanning the horizon, as it were, ready to make discoveries” (Kirzner 1997, 72). Indeed, conscious search is quite difficult if one does not start by knowing what one is looking for, as when Minniti and Bygrave (1999, 41) suggest that, “entrepreneurial alertness leads to something previously unimagined.”

Contemporary literature frequently cites Kirzner as evidence stressing the importance of the opportunity recognition (Ardichvili et al. 2003, Kaish and Gilad 1991, Kirzner 1979, Shane 2000). There are, however, wide variations in how much writers on opportunity recognition accept the unconscious nature of Kirzner’s entrepreneurial alertness. At one extreme, some suggest that entrepreneurial discovery is the result of classic management techniques that are chosen and consciously directed, abandoning entirely Kirzner’s view that entrepreneurial alertness is not consciously directed. Others occupy a more mixed position. Alvarez and Busenitz (2001) seem to include both the conscious and subconscious approaches but believe the distinguishing characteristic of entrepreneurs is their use of heuristics, defined as simplifying strategies. While they recognise that entrepreneurs make “significant leaps” (2001, 758), those leaps would seem in their view to follow from a conscious application of decision rules that allow them to deal with
ambiguous information and complexity. Studies of the source of entrepreneurial ideas provide evidence of both conscious search and spontaneous recognition, with Koller (1988) finding more opportunities found by discovery than by searching. Herron and Sapienza (1992) suggest that while the mechanisms underlying the search process may be open to debate, it “apparently involves a subconscious evaluation”; once it “has synthesized an opportunity, however, conscious evaluation will begin to operate” (52).

Whatever the balance, there appears to be widespread acceptance that entrepreneurial alertness has a strong intuitive or subconscious component. Ardichvili et al. (2003, 115) suggests that while conscious search is often important, on balance one should recognise the key role of alertness in recognising opportunities hidden in the information that flows past the future entrepreneur, concluding that whatever it is that happens in a process of passive search is a “more powerful determinant of discovery -- accidental or purposive -- than level of activeness of search. Therefore we include entrepreneurial alertness rather than search in our model”. Not dissimilar views are found in Baron (2004) and Gaglio (1997).

A qualitative exploration
To explore this notion of unconscious discovery of technology applications, one author has conducted a focus group of undergraduate mechanical engineers at the University of Sheffield. Using questions that were items from a scale on attention to use of technology (see below), the students were asked about how often they had realisations or discoveries about technology, a question important to the quantitative survey methodology reported below. While the answers varied to some degree, the general consensus was that these students felt that they thought about a wide variety of problems, and about once a month they would spontaneously recognise that some technology might offer a solution. Conversely, when discussing a new technology, they said that about monthly or more often they would seize on either an entirely new application, or more likely a further application of an existing technology. Together these results supported the premise that there is an on-going process of some kind that links problems or needs and alternative uses of technology. Critical to the survey methodology, they were then asked to describe some of those realisations to determine how tangible and consequential they were, and what they were doing at the time.

Some examples drawn from a focus group transcript (Rodriguez-Falcon 2006) are instructive:
Samuel: When asked about when a concern for a problem had led to a technology of some kind, Samuel described the experience of not wanting to get up out of bed to change the channel on his television set, setting off the idea of using Blue Tooth technology to link his cell phone to his television. When asked what motivated this realisation, he said “Laziness, I think.”

Samuel subsequently reconfigured his cell phone to control his television. Later he added remote control of his compact disc player. He now invites friends in and proudly shows his invention.

Beverly: The realisation she reported occurred while walking a substantial distance to the University on a cold morning that had turned warm by the time she arrived. “I start feeling hot, so [then I] just start wondering if you could develop a material or fabric that
sort of adapts to different climate or temperature changes…” When said she continues to think about the idea from time to time, and adds that, “Well it’s in the back of my memory, maybe subconscious; [I] don’t really think on it as much, but, yeah, it’s something that I’d like to address, maybe sometime.”

Timothy: His first recollection of a problem followed by recognising how a technology could help was not particularly impressive: when his electricity bill arrived in the post he recognised he had a problem, and he thought about taking advantage of the more efficient light bulbs on the market. This reminds us that all responses to questions about the frequency of linking technology to problems may be about mundane and well-established technologies, a point worth remembering when we see a large number of instances of recognition of applications reported in the larger survey below.

His second reported application idea occurred later in the interview, and occurred against a background that he was reading a novel that featured a group actively opposing any use of nanotechnology. While reading that book he had from time-to-time thought about how he might use nanotechnology. However, the recognition of a problem-technology linkage was in a conversation with his housemates about painting the inside of his house. After looking at colours they might use, he reported asking what if they could get a “paint that changes colour on walls…,” envisioning the possibility of a new kind of paint that would have complex molecules that might react to different electrical states controlled by the light switch.

Timothy also reported on an application link recognised on a class team that was assigned to an engineering problem to move an egg from point A to point B. His team had worked at brainstorming together to come up with novel ideas -- a form of directed search -- but did not reach a satisfactory design. Later, a team-mate went skiing, and after watching the chair lift operate, recognised that an egg-mover could operate on a wire. When he took the idea back, the team successfully applied the idea to their project.

Herman: He was unable to withdraw money from a bank machine with his gloves on. He took his gloves off, and at the time “I couldn’t hold the card properly and I started shivering and again the slot is so thin so it took me at least two minutes to find the slot.” He has since noticed “old people as they’re struggling to put their cards in the cash machine,” and he continues to wonder if a barcode scanner or a chip with user details could be installed instead.

Herman also thought of detachable heels to be used by girls who were taller than their dates, as well as expanding heels for the males. When he and a friend were later watching “a girl walk by and she was struggling to walk” in high heels, his friend suggested folding heels and Herman returned to thinking about his removable approach.

Lawrence: Lawrence came to Sheffield to study engineering because of an enduring interest in prosthetic hands, and he had recently seen a new technology “called nano-muscles, and it uses symmetrical currents to contract.” It came to him that the approach could also be used to communicate sign language, so that among other things a robot could communicate with the deaf. When asked what he was doing at the time he commented that he made the connection in the shower.
There is little evidence of conscious search here. Some ideas are mundane, and undoubtedly many have been discovered previously by countless others elsewhere. We know, for example, of an undergraduate at the University of Ulster and a postgraduate student at Heriot-Watt University who also recognised the value of removable heels. Whatever their economic value, however, the reported instances confirm the presence of an on-going and spontaneous process among engineering students where they from time to time link problems or needs to technology. The ideas seem to arise from a recurring personal experience, from a long-standing interest and/or from an assigned task. The triggers were variously recurring personal need, a new problem or standing in the shower, rather than the result of deliberate search. There, thus, seems to be reason to believe that there is some unconscious process that leads to discovery, and it appears that as a result of their specialised technical knowledge, those discoveries are heavily biased towards the use of technology.

Selective attention
There is a rich literature in cognitive psychology that supports the premise that individuals are attentive to information both consciously, listening and assessing information with focused attention; and subconsciously, without awareness that they are attending to other sources. A much cited article reported that while individuals varied in their abilities, for the most part a given individual can track around five to seven blocks of related stimuli at the same time (Miller 1956). As an unavoidable consequence of limited attention resources, the human mind has evolved to serve as a strong filter that simply screens out phenomena not of immediate concern. Broadbent (1952) and Cherry (1953) studied how this subconscious filtering worked in their classic dichotic studies. In these experiments, the subject is asked to wear headphones with left and right earpieces that carry different voices talking about different content. They found that, in general, if the subject is asked to listen with, for example, the right ear, he or she can later describe with accuracy what was said to that ear but will remember virtually nothing about what was directed to the other. A strong conclusion in this and other experiments that have followed is that individuals have a substantial capacity to attend wilfully to one source, and that focusing is enabled by the mind automatically filtering out information provided by other senses and sources.

While we do concentrate our attention resources on some channels and seemingly leave others unattended, it remains that somehow we still notice particular information if it appears in those other channels. The classic example of this process was first cited by Cherry (1953) as the cocktail party effect, where in a crowded and noisy room with many channels of information flowing with information you can suddenly notice that your name was mentioned, and automatically orient and direct your attention to the source. Cherry’s dichotic experiments also had the additional finding that there is a similar subconscious process that nonetheless continues to filter the unattended ear and recognises when the attention should be redirected. If the listener’s name is spoken into the unattended ear, attention is immediately switched to that voice without conscious effort.

The underlying premise is summarised by Moskowitz (2002) who holds that there is a strong literature that, “people avoid and approach stimuli prior to recognition, without the individual being aware of the motivational influence.” Note that this is not an ability to be commanded. We are selectively alert to information in a way that is not willfully directed in a process and we are not even conscious that it is on-going. (For a review, see Cowan
Hence the existence of entrepreneurial alertness as a subconscious process is at least plausible.

The literature is less clear on what conditions cause this process to focus on some and not other information. Given the widespread phenomenon of recognising one’s name, the literature question is what conditions are needed for selective attention to operate. This subconscious effect has subsequently been shown to include selective attention to a wide range of “self-relevant” information, but subconscious attention can also be directed by one’s conscious goals (Srull and Wyer 1986).

It might be supposed that individuals who are strongly motivated and practiced in pursuing technical ideas might be expected to have developed an unconscious alertness to cues that would trigger recognition of entrepreneurial opportunities based upon their particular interests and experiences. Those professionally involved in or studying government might be alert to linkages and possibilities involving policy change; managers and business majors would recognise and apply novel marketing ideas in new ways, and science and engineering professionals and undergraduates would, by virtue of their interests and hours spent on technical matters, notice technical solutions -- probably tied to their work or course of study, or perhaps to the pervasive Internet technologies that so many are using. If this is the case, then it is likely that such alertness is the result of the training of their attention to filter for and notice opportunities involving the linking of technology and problems or needs.

**Method and results**

The processes underlying opportunity recognition are addressed in a study which draws on data collected at the Universities of Cambridge, Sheffield, Strathclyde and York in the UK at the beginning of the academic year. After filtering out undergraduates who were not in engineering, and the engineering students in their first year (who in October had only just started at the university) and second years who had only one year of university experience, there were 494 completed surveys available for analysis. After a discussion of the measurement of technology alertness, the data are used to test the hypothesis that technology alertness is predicted by technology self-efficacy, venturing self-efficacy, and entrepreneurial intent.

**Measuring technology alertness and other variables**

**Technology alertness**

In an effort to measure the alertness concept, items were developed to see if individuals were sufficiently self-aware of instances of when they had recognised a technology-problem linkage, whether they would be able to provide a rough recollection of how frequently they had such recognition events, and whether such answers were random guesses or constituted meaningful data for analysis. Item A, finding oneself wondering in class about how something just learned could be used, and item B, remembering that upon learning a new applied concept they got excited about an application, are at the core of the scale used here (Table 1).

Two other questions were expected to be closely related phenomena. The results from the item about how often these engineering students in the larger study saw something in their studies that could be used to address a social need (Item E) suggest this occurs for 39.6%
of these engineering students once a month. A total of 26.0% of students noted that more than once a month they realised while thinking about a problem that there was a technology which could be used in a new way to provide a solution (Item F).

Table 1 - Factor structure of alertness to technology

<table>
<thead>
<tr>
<th>How often do you…</th>
<th>Frequency more than monthly</th>
<th>Component loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Wonder while you are in class or a lab whether something you just learned could be used to improve a product or process</td>
<td>47.0%</td>
<td>.744</td>
</tr>
<tr>
<td>B. Learn a new applied science concept and get excited about an application idea (whether or not the idea was right)</td>
<td>43.9%</td>
<td>.737</td>
</tr>
<tr>
<td>C. Use a tool or device and it occurs to you that the activity involves some principle you have learned</td>
<td>66.1%</td>
<td>.713</td>
</tr>
<tr>
<td>D. As you learn about a principle, you realise on your own that there are special cases when the principle does not hold up</td>
<td>33.3%</td>
<td>.695</td>
</tr>
<tr>
<td>E. Think about some social problem or need that could be addressed by something you are studying</td>
<td>39.6%</td>
<td>.642</td>
</tr>
<tr>
<td>F. Realise while thinking about a problem that there is technology that could be used in a new way to provide a solution</td>
<td>26.0%</td>
<td>.636</td>
</tr>
<tr>
<td>G. While watching a movie or television, you become very aware that something has violated a science or engineering principle</td>
<td>62.0%</td>
<td>.610</td>
</tr>
</tbody>
</table>

46.8% of variance extracted. Alpha for 7 items = .807

These four types of alertness (A, B, F and E) are the questions presented to the mechanical engineering students at Sheffield. As a set, these episodes of alertness occur monthly or a little less often, at the same rates as found in the qualitative interviews. If one draws a line at a frequency of more than monthly, the proportion that reports a higher frequency varies from 26.0% who more often see new uses of technology, to 47.0% who more than monthly wonder while in their classes or laboratories about using what they have learned to make product or process improvements. It is the tangible nature of the examples the Sheffield student could provide that adds some credence to the belief that the instances of discovery and linking are real.

The other statements are a diverse set of questions about the recognition of science and engineering principles in daily life, and were expected to form a different scale component.

The result suggests that technology awareness is more diffuse, or perhaps more accurately, less differentiated among these students. All items have a component loading of .6 or higher on the same component, and a test of their reliability as a scale yields a satisfactory Alpha statistic of .807. A result that suggests the need to develop the scale further is the fact that the factor loadings only extract 46.8% of the variance.

Other variables
Conceptually one would expect alertness to be higher among students who are confident about their abilities, and their intention to be entrepreneurs. The self-efficacy measures follow the work reported by Lucas and Cooper (2005, 2006) that present measures of entrepreneurial intention and self-efficacy. That latter work demonstrates that there are two, separable forms of self-efficacy that can be measured with scales designed to elicit confidence in two different domains. One scale measures confidence in venturing, which is to say entrepreneurship in its more general sense, and is based on a series of judgments
the individual provides about their confidence in their ability to, among other tasks, write a business plan, estimate costs of a venture, select a marketing concept, and recognise an opportunity. The second scale has to do with confidence in one’s abilities in the domain of applied technologies, including the tasks of grasping the best uses of a new technology.

To determine whether entrepreneurial intention drives alertness, we use a scale also developed elsewhere. The items include intermediate and eventual intention, with one item concerned with an opportunity in “the next few years,” and the other open ended, “At least once I will have to take a chance to start my own company.” For the present study, 20.7% of the undergraduates agreed or strongly agreed on a seven point scale that they would take a near-term opportunity, while 23.0% agreed or strongly agreed that they would at least once start a company (Table 2). A similar proportion of 19.6% agreed that a high risk/high pay-off venture appeals to them, and 20.5% agreed that they often think about ideas and ways to start a company. It might be noted that this level of agreement suggests a relatively high level of entrepreneurial intention. When combined in a scale, the Alpha coefficient of reliability is found to be .80.

Table 2 - Entrepreneurial intention scale

<table>
<thead>
<tr>
<th></th>
<th>Percent Agree or Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I see an opportunity to join a start-up company in the next few years, I’ll take it.</td>
<td>20.7%</td>
</tr>
<tr>
<td>The idea of high risk/high pay-off ventures appeals to me.</td>
<td>19.6%</td>
</tr>
<tr>
<td>I often think about ideas and ways to start a business</td>
<td>20.5%</td>
</tr>
<tr>
<td>At least once I will have to take a chance and start my own company.</td>
<td>23.0%</td>
</tr>
</tbody>
</table>

Alpha = .80

Results

Two background factors commonly found to be predictors of entrepreneurial pursuits are gender and having a father that owns a business. Both are found here (see Table 3) to be consequential, with men having higher levels of self-efficacy for venturing (r = .128, p < .001) and entrepreneurial intent (r = .234, p < .001). The relationship between gender and technology applications self-efficacy is even higher (r = .254, p < .001). The reported frequency of instances of technology alertness is also higher for men (r = .234, p < .001). Father’s entrepreneurial background plays less of a role, although consistent with the literature it relates both to venturing self-efficacy and entrepreneurial intention.

Two other checks on the data are reported for university and year of study. Because the largest number of undergraduates in this study are at the University of Strathclyde in Scotland which has a university system somewhat different from the three English universities, it seems prudent to see if its students are different on these variables. No differences are found, although it is clear that on average the Strathclyde participants in the study are more often in their fourth year (r = .381, p < .001). This leads to a further check to see if the students starting their third year are in some way different from those starting their fourth year. No meaningful relationships are found between year of study and the other variables and university and year are dropped from further analysis.
The strongest relationship in the study is between two types of self-efficacy (.646, p < .001). This result is to be expected, with those confident in one domain likely to be confident in others. A relationship this strong does create an interpretation problem that is resolved below by regression analysis that separates the effects of the two types of self-efficacy on technology alertness. Another expected finding is that venturing self-efficacy is related to entrepreneurial intention (.245, p < .001), a finding consistent with the literature.

Our central concern is with the effects of self-efficacy and intent on technology alertness, to test the view that alertness follows from domain-specific confidence and intention. The strongest relationship is found here between technology self-efficacy and technology alertness (.342, p < .001), followed closely by the relationship between entrepreneurial intention and alertness (.303, p < .001). The relationship between venturing self-efficacy and alertness is somewhat lower, although still quite significant statistically at r = .282, p < .001.

As a next step, regression analysis is used to separate out the overlapping effects of gender, father’s business experience, the two types of self-efficacy and entrepreneurial intention on alertness to technology application. Because the units of measurement differ substantially from one predictive variable to another, the standardised beta coefficients are provided so one can compare effect sizes. Consistent with the view that alertness is domain specific, technology self-efficacy and entrepreneurial intent are the strong predictors of technology alertness (beta = 5.175 and 5.088, both with p < .001) (See Table 4.) The effect of gender remains consequential when the effects of these other factors are separated out, but is still consequential (beta = 3.133, p < .001), while a father with an entrepreneurial background plays no role at all (beta = .019, not significant).

The striking result is that venturing self-confidence would appear to play no role at all in predicting alertness to new uses of technology (beta = -.025, not significant).
Remembering the strong relationship between the two types of self-efficacy, it appears that the correlation found between venturing self-efficacy and technology alertness is spurious, an artefact of their shared correlation with self-efficacy for the application of technology.

### Table 4 - Regression Analysis

<table>
<thead>
<tr>
<th></th>
<th>Standardised Beta</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>5.236</td>
<td>.000</td>
</tr>
<tr>
<td>Men</td>
<td>.151</td>
<td>3.313</td>
</tr>
<tr>
<td>Father owns business</td>
<td>.019</td>
<td>.437</td>
</tr>
<tr>
<td>Venturing self-efficacy</td>
<td>-.025</td>
<td>-.407</td>
</tr>
<tr>
<td>Technology self-efficacy</td>
<td>.303</td>
<td>5.175</td>
</tr>
<tr>
<td>Entrepreneurial intent</td>
<td>.249</td>
<td>5.088</td>
</tr>
</tbody>
</table>

Multiple r = .490; r square = 24.0%; F = 25.440; df = 5, 402; p < .001.

### Discussion and conclusions

This research suggests that entrepreneurial alertness as it relates to technology is an unconscious process of recognising linkages and solutions. Once recognised, they would appear to be the subject of conscious attention and evaluation. It seems likely that in a vast proportion of instances the idea is dropped, but the qualitative interviews suggest that some become recurring notions that are elaborated or refocused to test them as solutions to the context at hand. Thus, alertness to technology applications is a domain-specific form of entrepreneurial alertness found among engineers. When the opportunity is tangible and within the resources of the individual, like the mobile phone remote control and the wire egg-mover, the individual acts on the discovery, certainly an encouraging outcome that suggests that a future of technical innovation.

The strong relationships found in the regression analysis provide some indication of the origins of this alertness. Based on domain self-confidence, one could surmise that alertness is strong when the individual is testing and demonstrating that competence to themselves, and when the occasion permits, to others. It seems reasonable to expect analogous alertness among others. For example, those confident in their sales ability and who intend to pursue sales careers would be alert to opportunities for new sales approaches or channels. One can predict that as education and training, work experience, interests and intentions become more differentiated, the focus of alertness will increasing diversify from one individual to the next.

Whether there is a general form of entrepreneurial alertness is not tested here, and requires comparative data. Despite the fact that the students in this study were found to have relatively high entrepreneurial intent, however, the finding here that venturing self-efficacy among engineers does not increase alertness over that which is predicted by technology self-efficacy is very suggestive. It seems self-evident that public policy would like to see large numbers of engineers who “get excited about an application idea” and “realise while thinking about a problem that there is technology that could be used in a new way to provide a solution.”
It is likely that it is technology practice and subsequent enhancement of self-efficacy rather than entrepreneurship courses that strengthen this form of alertness. In that context, the most important thing we do not know from this research is whether the push for entrepreneurship among students detracts from the development of technology alertness in their fields of study.

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On the Recognition of Venturing Opportunities in Science and Technology

William A. Lucas, Cambridge-Massachusetts Institute, MIT,
77 Massachusetts Avenue, Cambridge, MA., USA (walucas@mit.edu)

Sarah Y. Cooper, Hunter Centre for Entrepreneurship, University of Strathclyde,
26 Richmond Street, Glasgow, G1 1XH, Scotland (sarah.cooper@strath.ac.uk)

and

Elena M. Rodriguez-Falcon, Department of Mechanical Engineering,
University of Sheffield, Mappin Street, Sheffield (e.m.rodriguez-falcon@sheffield.ac.uk)

Summary
This paper seeks to understand the psychological mechanisms which support the recognition of science and technology-based opportunities for new ventures. Opportunity recognition is viewed as a critical skill in venturing activities, but there is doubt about the mechanisms involved. The entrepreneurship literature contains a tradition of seeing opportunity recognition as a less than conscious process, and certainly not the result of carefully crafted search processes. Schumpeter and Kirzner (1997) believe that entrepreneurial alertness is a non-conscious process of recognition; Herron and Sapienza, feel that the operation of initial discovery of entrepreneurial ideas “involves a subconscious evaluation” (1992, 52), and Ravasi and Turati consider that the entrepreneurial idea starts with an “initial intuition” (2005, 138).

Two literatures offer contrasting explanations for how a non-conscious process of entrepreneurial alertness operates. The first is more a personality trait, recognising that large numbers individuals engage fairly deeply with almost everything they are told. Such individuals are said to have a “need for cognition” (Cacciapo and Petty 1982). Evidence shows that those with a need for cognition have many attributes associated with entrepreneurs and university-trained scientists and engineers, and with psychological correlates, like self-confidence, one associates with entrepreneurship. A second literature offers an alternative, possibly over-lapping, view that individuals have a learned but unconscious “directed attention” to potential entrepreneurial opportunities. Individuals who are strongly motivated and practiced in pursuing venturing ideas would be expected to have developed an unconscious alertness to cues that would trigger recognition of opportunities based on their particular interests and experiences. Even among individuals with common science and engineering skills and experiences, some will have an entrepreneurial alertness that would trigger recognition of facts and linkages that involve new venture possibilities that others would not perceive.

This paper reports on on-going research exploring this second approach, attention to use. Qualitative evidence is presented from a focus group discussion of opportunity recognition conducted with mechanical engineering students at the University of Sheffield. A scale for measuring attention to use of technology is then offered, which includes items used as prompts in the focus group discussion. Results from this scale, given to 494 science, mathematics and engineering students at four UK universities are reported, showing that a viable scale can be created, and how this correlates with pre-entrepreneurial behaviour, entrepreneurial intent, venturing and technical self-efficacy.

The conclusion to the paper addresses the implications of recognising directed attention as a major component of opportunity recognition.
Did you inscript your tacit knowledge?

Davide Dell’Anno
Faculty of Economics
Second University of Naples
davide.dellanno@unina2.it

Manlio Del Giudice
Faculty of Economics
Second University of Naples
manlio.delgiudice@unina2.it

Maria Rosaria Della Peruta
Faculty of Economics
Second University of Naples
mariarosaria.dellaperuta@unina2.it

Abstract

The management of knowledge is increasingly considered as a main source of competitive advantage for corporations. It is argued that organizations enjoy a competitive advantage if they know how to expand, disseminate and exploit organizational knowledge internally. Moreover, organizations can achieve their strategic goals by encouraging knowledge sharing, flexibility and adaptation to change. Furthermore our position is that tacit knowledge sharing can lead to knowledge stratification. And that it is likely to lead to encode knowledge in behavioural schemas, apparently similar to organizational routines, but as a matter of fact more complex and refined: the cognitive scripts. Even if apparently similar to organizational routines, the scripts strongly differ from them in terms of power of replication, of inertia degree, of search potential. The present study focuses on the analysis of the script localization in the organization as an important starting point for the understanding of the dynamics of knowledge stratification and encoding. Thus hypothesizing kinds of knowledge re-use within spin off decisions, as well. The plausibility of the mentioned hypotheses are tested by a multivariate statistics approach.

Keywords: organizational routine, script, academic spin off, inscription, collective knowledge

1. Introduction
Did you inscript your tacit knowledge?

There is a growing debate on the relationship between codified and tacit knowledge and on the role of codification in the dynamics of knowledge reproduction, or exchange. In this context, it would be a mistake to emphasize too much the “storage and transfer aspect” as the main competitive advantage of codified knowledge over the maintenance of knowledge in tacit forms such as organizational routines. By overemphasizing the use of codification as means for storage and transfer, it would not do enough justice to the key role of knowledge codification: to make new cognitive devices emerge likely to produce knowledge. In one simple word, the knowledge “representation” problem. Particularly, codification provides a spatial device to screen and classify information, opening new opportunities for the modelling or representation of knowledge, a condition for quick knowledge production and accumulation. Knowledge representations are made as a prelude to the act of codification, while acts of codification shape the nature and appropriateness of knowledge representations. The value of knowledge representation moreover depends upon on the extent to which it can be successfully employed in an “inscription process”, a learning and operating activity, involving the execution of scripts in order to simplify the cognitive effort of the individual in every managerial operation.

Our aim is furthermore to study the role of academic communities of practice in stimulating both tacit knowledge stratification and inscription processes. As well as to hypothesize kinds of knowledge re-use behaviours within spin off decisions. Our focus provides us with a departure point for re-examining the interaction between individual skills and organizational capabilities as the basis of organizational routines. Then, we focus on a “script based” approach: scripts emerge from our empirical researches as a more dynamic evolution of organizational routines (Dell’Anno & Del Giudice, 2002; Maggioni & Del Giudice, 2004; Dell’Anno & Del Giudice, 2004; Dell’Anno, Van der Sijde & Del Giudice, 2005; Maggioni & Del Giudice, 2005; Maggioni & Del Giudice, 2006). Our position is that the local context in which routines emerge and learning takes place does matter, and leads to behavioural schemas (i.e. the cognitive scripts) that strongly differ from them in terms of power of replication, of inertia degree, of search potential. By following this approach, we point on the analysis of the script localization in the organization as an important starting point for the understanding of the dynamics of knowledge inscription. Moreover, our aim is to deepen in the specific overlapping levels between organizational routines and cognitive scripts, guiding scientific work in local academic communities, and managerial scripts required in order to identify and exploit new technological opportunities in a specific industry. These are expected to account for variations across different academic communities in the support, which is provided for the development of the organizational capabilities of spin-off firms in this industry.

2. What routines are: collective performance of a script or conscious and collective repetition of action?
Most of the criticism of codification could be applied to individualistic treatments of tacit knowledge. Tacit knowledge explains why firms hold together, project teams need to co-locate and technology transfer seems to be difficult. While tacit knowledge no doubts plays a small but important role in these processes, these are many more important causal processes at work, such as those relating to social interaction between individuals (Nightingale, 2003). So, when Nelson and Winter (1982) are discussing what routines are, they support Polanyi’s idea that knowledge is an embodied process and that all our conscious attention is dependent on a whole range of unconscious, tacit processes (Polanyi, 1969).

The following literature review on cognitive scripts and organizational routines represents an overview for applying the “inscription” concept to a micro-level perspective, by emphasizing the cognitive processes of the individuals (Ashforth and Fried, 1988); it can be useful for better focusing on a macro-level that may emphasize structural and institutional constraints (Nelson and Winter, 1982), as well. The analysis levels are obviously blurred, because “context” factors influence script selection and performance (Gioia & Poole, 1984) and the cognitive processes of individuals can enact situational structures (Weick, 1979).

**Cognitive scripts**

The first conceptualization places routine in the neighbourhood of concepts such as the script.

Cognitive scripts are a category of schemas, which entail also plans, categories, implicit theories, prototypes and heuristics (Wofford, 1994, p. 181). Schemas are knowledge structures in memory that people use to understand their environment, handle problems, and form expectations on results. A script is then “a cognitive memory structure consisting of the objects, events, roles, conditions, sentiments, and outcomes that occur in a sequential pattern in familiar tasks and situations” (Wofford, 1994, p. 181).

Louis (1980) noted that relatively inarticulate cognitive scripts, which are coherent sequences of events expected by the individual, likely to drive many behaviours. Taylor and Fiske (1978) asserted that most of our every day decisions are made ‘off the top of our heads’. The scripts underlying these decisions are reviewed only when the individual senses “something out of the ordinary”. A cognitive script is then a conceptual structure that allows individuals to approach familiar events in a relatively similar fashion. More specifically, Choo (1996) argued that “a cognitive script is a sequence of actions and events in an individual’s knowledge structure that enables that individual to understand a specific situation or context and guides his or her behaviour in that situation or context” (p. 339). Moreover, Edwards (1994) noted that scripts are generalised event schemes, which are derived from concrete experience of events and thus represent “how the world works” (p. 211).

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1 Tacit knowledge is a category of unconscious neurophysiological causation that provides the basis and context to action and conscious mental stages.
Did you inscript your tacit knowledge?

Nooeboom (2000) recently visualised scripts as a set of events, or nodes, which produce outcomes that are then introduced in the next node of the script or nodes outside the current script. A simplified version of the visualisation that he proposed is then provided in Fig. 1:

**Fig. 1: visualisation of scripts (Nooeboom, 2000, p. 126)**

Nooeboom (2000) described scripts as “one’s cognitive, categorical framework or absorptive capacity” (p. 126). He argued that scripts can be seen as series of nodes, which correspond to sets of events or actions. These events or actions can be “substituted” into the nodes, and thus become part of the script. Nooteboom furthermore argued that nodes produce outcomes that can then be substituted in subsequent nodes. It is also possible that outcomes of a particular node are substituted into nodes of different scripts, or in no other script at all. Nooteboom’s view is relevant to our paper since it emphasizes that actions can be invoked “automatically”, if they result from the substitution of outcomes of earlier nodes. In earlier studies, Shank & Abelson (1977) and Gioia & Poole (1984) regarded scripts as cognitive representations of rule-guided, stereotypical sequences of events and actions. Shank & Abelson (1977) treated scripts primarily as cognitive phenomena, contrary to Barley & Tolbert (1997), who propose that scripts are “observable, recurrent activities and patterns of interaction characteristic of a particular setting” (p. 98). They focused more on the embodied actions in the scripts. Gioia & Poole (1984) pointed out that a script contains knowledge on sets of events or behaviours (“weak” scripts according to Gioia & Poole, 1984) and their sequence (“strong” scripts, Gioia & Poole, 1984, p. 449). They provided a definition that focuses both on the mental storage of scripts (the cognitive component) and on the resulting behavioural regularities. They defined a “script” as “a schema held in memory that describes events or behaviours (or sequences of events or behaviours) appropriate for a particular context” (p. 450). Moreover they discussed the notion of “scripts” instead of “cognitive scripts”. Gioia & Poole emphasised the sequence of events or behaviours, instead of their cognitive representations, as well. Although these last are practically difficult to separate, this paper focuses on ‘scripts’ in order to underscore the idea that scripts can be more than cognitive structures. They can be part of habitual action in a very realistic manner, just as Barley & Tolbert (1997) propose. However, it cannot dismiss the associated cognitive phenomena, as these
cause specific behavioural regularities to be displayed. Knowledge on how and when scripts are invoked, and when they are not, is needed to provide explanations of changes in repeated behaviours.

The definition of scripts that is used in this paper accommodates processes of cognitive adaptation that individuals can experience when confronted with novel situations. These cognitive processes include the processes that lead to “automatic” script performance or conversely, cognitively controlled processing of situational information. This is coherent with Gioia & Poole (1984) early assumptions: “scripted organisational behaviour is often performed unconsciously […] although active cognition is involved during the process of script development and when encountering unconventional situations” (p. 449). As such, the associated cognitive dimension is an important part of the present study, although primarily related to the invoking or dismissing of scripts as well as the “invention” of new scripts. Therefore, we would approach a slightly adapted definition of a script: “a regularly performed schema held in memory that describes events or behaviours (or sequences of events or behaviours) appropriate for a particular context”. This definition focuses not only on its cognitive representation, but also on the regular performance of the schema, producing potential behavioural regularities, that can result in the production of routines, as the next paragraph will argue.

**Routines**

It appears that a number of authors in the managerial literature employ the word “routine” in the same manner as others employ the term “script”. In the present study, routines are collective, observable behavioural regularities, whereas scripts are the underlying individual cognitive regularities that may or may-not accompany routine behaviour.

Similar to scripts, routines allow actors to make complex decisions, without resorting to extensive search behaviour for alternatives and preferences. Their value lies in the reduction of the “complexity of real-world decisions to manageable levels by limiting the scope of the “problematic search” for solutions” (Sharp, 1994). Nelson and Winter (1982) argued that routines reduce decision complexity by providing a narrow range of environmental signals (cues) that indicate possible causes for action (see also March & Simon, 1958). The price that one has to pay for increased simplicity is that actors do not oversee all possible alternatives, but only parts thereof. Stein (1997) noted that the cognitive processes of reduction and elaboration can lead to choice biases, as well as influencing the sensory inputs we give attention to and those we do not. Giddens (1984) from his side saw routines as the very fabric of social structure. Structure exists because of the continuous production and reproduction of action. Yet, at the same time, routines enable the continuity of the personality of the agent. With different words: routinization enables structure as well as personality of those operating under the influence of structure.

Sharp (1994) suggested that routines can be seen as Standard Operating Procedures (SOPs) that facilitate decision making in the face of complexity and
uncertainty. In this, he makes no distinction between formal routines and factual routines. Burns & Scapens (2000) and Cohen & Bacdayan (1994) did make this distinction. They perceived routines to be the informal counterpart of formal rules of behaviour. They separated Standard Operating Procedures from routines-in-use. From their perspective, rules are the formalised statement of procedures, whereas routines are the procedures actually in use (Burns & Scapens, 2000, p. 7). A somewhat different concept of routine behaviour has been provided by Louis (1980). She observed that in normal everyday action, individuals operate in “a kind of loosely pre-programmed, non-conscious way, guided by cognitive scripts” (p. 239). She suggested that conscious thought does not play a major part in these activities. Following this approach, Porac et al. noted that “many experienced employees perform their work with highly routinised behavioural patterns and thus may not engage in much causal reasoning simply because work has become “scripted” (1983, p. 286). They referred to scripts, but related notions have also been used, including schema (Weick, 1979) and habitualization (Berger & Luckmann, 1979). These concepts are more individually oriented than the concept of routines noted above.

Routines, whose development and application by organizational members is facilitated by written rules, not only confine the activities of individuals but also enable them (Adler & Borys, 1996). Rather, the process causing some rules to be evoked more than others point to routines can occur due to the performance of scripts. This duality is one of Gidden’s (1984) core concepts. Routines cannot always be made explicit, for they also encompass “tacit knowledge” (Nonaka & Takeuchi, 1995). This aspect was touched upon when Nelson and Winter (1982) argued that routines are the skills of an organization. The performance of an organizational routine involves the effective integration of a number of component subroutines (themselves further reducible) and is ordinarily accomplished without “conscious awareness” – that is, without requiring the attention of top management. This sort of decentralization in organizational functioning parallels the skilled individual’s ability to perform without attending to the details” (pp. 124-5).

Finally, Stinchcombe’s (1990) notion of routines illustrated the latter: “a skilled person becoming really expert and fast at doing some number of distinct tasks”. Stinchcombe recognised that the skill of skilled workers is only in part attributable to action routines. In part, the skill of skilled workers is also dependent on “the many principles of decision which tell workers when to use one routine, when to use another” (1990, p. 33). Implicitly, Stinchcombe distinguished between (action) routines and scripts on the same basis: the motor skills of acting and the cognitive skills of deciding.

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2 March (1989) observes that routines can be related to rules. Rules in themselves are not routines, as there are multiplicities of rules applicable to each situation.

3 Thus, scripts extend formal rules: containing information on how to behave when certain rules apply, scripts extend formal rules into minds of individuals.
This points us to a distinction that appears to be relevant: routines resulting from the collective performance of a script vs. the conscious and collective repetition of action⁴.

3. **On the processes of representation and reproduction of knowledge**

The complex relationships between scripts and routines emphasize that the individual and collective levels are not independent of each other, but interact with each other iteratively and continuously.

Our primary contention about *how routines are used* within the firm provides us with a departure point for re-examining the role of script construction, which serves to reproduce and extend the repertoire of individual and collective capabilities.

Our purpose is then to develop an analysis of the processes of composition and delivery of scripts (“inscription”⁵) in relation to a major influence on the acquisition and exercise of skills (that are not or cannot be completely specified) and on methods of coordination for assembling these skills into routines.

We especially stress the cognitive and organizational mechanisms mobilized by the codification process. The formation and use of knowledge depend on the nature of the organizations and other collective sets. Knowledge, as a result of a social process, raises itself considerable cues for further analysis; particularly, the need to understand how knowledge can be transmitted from the level of the organization to an individual, and reciprocally, seems to be an intriguing one. The managerial researches (Nonaka and Takeuchi, 1995) showed that this transmission would require different conversion mechanisms (tacit to codified, codified to tacit, etc.) to operate within a given organization and between different organizations. They clearly emphasized that the individual/collective dimension strongly interferes with the tacit/codified dimension.

Our research idea is then the following: by holding the knowledge transfer “tools” an individual implies obviously the mastery of codes and/or languages but it also includes knowledge about the mode of conversion of knowledge that are the ways through which individual knowledge becomes collective (and reciprocally), tacit knowledge becomes explicit (and reciprocally), etc.

However, it is necessary to make a distinction (Steinmueller, 1999): between the process of *extension* (i.e. the process of *using the representation*) and

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⁴ From the point of view of economics, we can refer to the definition of Cohen et al. (1996, p. 683) in the sense that routine is a capacity to generate (collective) action, to “guide or direct an unfolding action sequence, that has been stored in some localised or distributed form”. Then, routines guarantee the regularity and predictability of individual behaviour necessary for collective action.

⁵ “The composition and the delivery of scripts consist of sequences of words, gestures, pictures, sounds and other expressions that can be symbolized and which facilitate the reproduction of human works and expressions” (Foray and Steinmueller, 2003, p. 299)
the knowledge reproduction process. And, of course, between the process of representation (i.e. the process of creating the codes) and the knowledge reproduction process itself.

There is an implicit strategic dimension in the second situation insofar as the adopted codes and modes of conversion should take into account the abilities of the receiver. And in this respect, codes, and especially languages, are not neutral means to transmit knowledge. They include intrinsically a representation of the world and mobilize different amounts of cognitive resources, both for the emitter and for the receiver.

We wish furthermore to emphasize that the devising of an effective script for transferring knowledge (such as problem-solving) is rather different from that of creating a sort of blueprint or instruction manual described by Nelson and Winter (1982) as instances of explicit information. The knowledge conveyed through the inscription process⁶ amounts to “skills”. The problem is that the word “skills” may seem ambiguous; it encompasses the capacities, like simple information recovery, as well as much more cognitively complex activities, such as problem-solving. Our contention is that scripts can be and are devised to encompass the full range of activities encompassed by skills. This is because scripts may incorporate heuristics, experimental investigations, analogies, metaphors or other figurative expressions that employ the natural language abilities of the intended recipient. In this sense, devising an appropriate script involves anticipating the mature understanding of an individual who has already mastered a body of knowledge. The potential for developing scripts that take account of the cognitive capacities of the receiver raises doubts about Nelson and Winter’s concerns about the difficulties of articulating knowledge, including time-rate difficulties in utilizing explicit information or the difficulties of parsimonious description. Nelson and Winter are more successful in reminding readers that scripts, regardless of how they are acquired, must be “internalized” in much the same way as an actor may mediate between the memorizing of a text and the actual performance of the part (Foray and Steinmueller, 2003).

The main questions that arise about the effectiveness of scripts are whether the individual delivering it will be able to master the outlines of the script in sufficient detail to execute it. As well as, whether those receiving the “performance of the script” will succeed in comprehending its intended purpose and internalize the knowledge that it is meant to reproduce. It is certainly possible to devise “bad scripts” that are too detailed to be effectively executed or that are incomprehensible to or unusable by their audience. These possibilities should not be taken as demonstration of an inherent impossibility to articulate knowledge in explicit or codified forms through the use of appropriate scripts. Nor should the variability with which individuals are able to comprehend scripts and thereby acquire knowledge,

⁶ The process of inscription is complex. It involves transforming knowledge into a form that enables effective performance of complex tasks by individuals who may or may not have a clear understanding of the underlying principles of design or operation of the component of the system that they are called upon to operate or maintain.
the observable differences in “talents”, be taken as evidence of a fundamental inability to articulate knowledge.

Our intention in this paper is to localize reproductive behaviours in the processes of inscription and the alternatives to inscription that involve ad hoc social interaction processes.

4. The role of “communities” as context for the emergence of scripts.

According to our vision, it is essential to identify the places where the modes of conversion of knowledge are activated, where the translation of local codes to organizational language (and reciprocally) is made, etc. We suggest that generally the level of interaction of small groups (communities) is essential to understand the process of transformation and transmission of tacit knowledge from the individual to the organization (and reciprocally).

Following this approach, we took inspiration from those authors working on communities of practices or epistemic communities. Every organization is made up of many communities of practice (i.e. groups of people committed to the same practice and sharing similar working visions), in which learning is not a matter of conscious design or recognizable rationality and cognitive frames, but a matter of new meanings and emergent structures arising out of common enterprise, experience and sociability—learning by doing (Cohenet & Llerena, 2003; Ancori, Bureth & Cohendet, 2000).

The role of work-based communities in generating knowledge has been studied with reference to different fields (e.g. to the context of physicists and molecular biologists (Knorr Cetina, 1999); to the researchers engaged in the design of a new technological artefact (Garud & Rappa, 1994); to the aerospace engineers (Constant, 1999)). Scholars labelled these communities differently, according to the mode of identification of their members and to the nature of their work. Epistemic cultures is Knorr Cetina’s term to describe communities identified with the process of creating knowledge itself, e.g., research scientists.

The concept of epistemic community heavily relies on the socialization of knowledge, emerging overbearing from routines and repeated interactions, rather than encrypted in rules or in an organizational design. They comprise “agents who work on a mutually recognized subset of knowledge issues, and who at the very least accept some commonly understood procedural authority as essential to the success of their collective building activities” (Cowan et al., 1999).

The concept of community enriches the organizational representation of knowledge-based activities. The epistemic community is more than a coordination

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7 The Japanese term “ba”, introduced by Nonaka and Konno (1998) as a useful way of referring to the virtual and real spaces needed to nurture learning and knowledge creation, seems to have some similarities with the concept of a “community of practice”, where members of a community learn by participating in the community and practicing their jobs.
Did you inscript your tacit knowledge?

device insofar as it incorporates learning infrastructures. These embedded infrastructures of learning are built into the routines and the daily practices of members, and features all the communities of practice that are to be found within and across organizations.

As a result, we have gradually shifted our research focus toward studying how organizations evolve by adapting knowledge bodies, shared by their members; we empirically recognized that the organization must develop common rules, common knowledge, collective learning and incentive schemes to cope with the need for circulation and creation of knowledge; and that in this respect, many of these processes take place at the collective tacit level.

5. Academic “communities”, scientist - entrepreneurs and spin-off firms

The spatial dimension of knowledge flows is conditioned by the social organization of the individuals who collectively generate the knowledge. Firms accrue defendable advantages when social identification within the firm is strong and firm-specific organizing principles guide the development and application of new knowledge (Kogut & Zander, 1992). But the identification of employees with wider work-based communities increases the porosity of firm boundaries around the creation and transmission of knowledge.

The problem of knowledge exploration and exploitation in the context of work-based communities has recently surfaced in studies of science-based firms, which rely on science, and hire scientists, to innovate.

By analysing the early development of science-based firms spun-off from university laboratories, recent studies have pointed out how “founding laboratories” constitute a key source on which science-based firms rely for their comparative advantages, highlighting the tacit knowledge regarding founding ideas which founders bring into a firm.

However, these are important differences between the concepts of community of practice and ba. Whereas a community of practice is a place where members learn knowledge that is embedded in the community, ba is a place where new knowledge is created. Whereas learning occurs in any community of practice, ba needs energy in order to become an active boundary ba where knowledge is created. Whereas the boundary of a community of practice is firmly set by the task, culture, and history of the community, the boundary of ba is set by its participants and can be changed easily. Instead of being constrained by history, ba has a here-and-now quality. It is created, it functions, and then it disappears, all as needed. Whereas the membership of a community of practice is fairly stable and whereas new members need time to learn about the community of practice and become fully participatory, the membership of ba is not fixed, for participants come and go. Finally, whereas members of a community of practice belong to the community, participants of ba relate to the ba.
Focusing primarily on the role of science transfer support institutions, these studies have largely left unexplored, the role organizational structures governing scientific research itself play in supporting entrepreneurial activities of scientist.

Our study discusses and empirically verifies how academic communities inside universities, in which scientist nevertheless have been guided in their research by organizational routines that overlap with routines required to identify and exploit new technological opportunities in a specific industry, place top scientists from these communities in a comparatively advantageous position to build up spin-off firms.

Research methodology and sampling procedure

The approach followed in this research has consisted in a back-survey. The first step has been the selection of entrepreneurial contexts marked by two eliciting conditions: a widespread entrepreneurial framework and a corporate willingness to transfer knowledge. The research has focussed in particular on the effects of a cross-fertilization approach in academic contexts favouring the development of a fertile soil for the exchange and for the stratification of knowledge which will then be reflected in individual’s managerial behaviours (Prahalad & Hamel, 1990). This study has aimed at understanding whether it is possible that the result of an inscription process in an academic community of practice can lead to a spontaneous process of corporate creation through spin off. As a main result of an inscription process we looked at the codification of tacit knowledge stratified and exchanged among the members of a same research workgroup in a cognitive script.

Following this approach, the first step has consisted in searching, by the means of informal in-depth interviews, within the academic organizations promoting spin off processes (Universities, Laboratories and Research Centres), informal highly iterative practices or procedures, tacitly accepted, shared in communities of practice and encoded by individuals. In simple words, we just searched for inscription processes, stemming from knowledge socialization, that which might lead the individuals to activate spin off initiatives. In brief, this research aimed at investigating the possibility of transferring successful tacit scripts (emerged from an inscription process) making up the cognitive map of the parent organization, as well as of reproducing these scripts through spin off processes. The analysis, based on an empirical inductive model, has stemmed from direct field observation supported by a previous bibliographical survey by also considering that empirical studies on

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8 This research has been developed thanks to funding of Italian Ministero dell’Università e Ricerca (MIUR) as part of a two-year National Research Project (Prin Cofin 2001 and 2003) and has involved the Faculty of Economics of Seconda Università degli Studi di Napoli as project coordinator and the Nikos Center at the University of Twente, the European most remarkable spin off incubator, and the Department of Marketing and Entrepreneurship of the Grenoble Graduate School of Business (Group ESC Grenoble). The research contact database is being continuously updated: in consideration of the scientific results obtained and the innovation of the hypothesis formulated, the research as such may be considered still in progress.
organizational learning and knowledge transfer are quite scanty in the European managerial literature, most of the research about entrepreneurship and organization originating in the USA.

One of the critical phase of our work has consisted in identifying the target to be researched. In order to obtain a significant classification of the spin off processes, a number of geographical areas has been first selected by taking into account the number of spin off cases already occurred in the local academic context. Secondly, some of these geographical areas have been sorted out for their relevant scientific value, as being marked by significant homogeneous features (criteria for their selection have included the yearly average number of spin offs as reported in scientific literature, their relevance on the web and in the relative scientific literature, etc.). In particular, three “macro-areas” have stood out: Europe, the USA and Canada. In each of these areas some sub-regions have been further identified and selected. Lastly for each of the selected regions the local academic organisations have been identified which would result involved in processes of know-how/technology transfer and spin off. Starting from those premises, our sample has been assembled by gaining contacts of similar institutions spurring technology transfer and spin off promotion from various databases: AUTM (Association of University Technology Managers), Nikos Center (University of Twente), Simon Fraser University, Southern California Biomedical Council, INFM.

As concerns this analysis, the investigation has covered geographical areas and institutions having homogeneous distinctive features in terms of academic spin off processes. As a whole 252 organizations have been selected as involved in academic spin off processes, whether as parent organizations and as spin offs, all of them concerned with IT, TLC and Life Sciences.

**Empirical analysis**

The first step of the analysis has consisted in an exploratory study aiming at investigating the main effects of an inscription process. This phase has involved the building up of a set of data from which the information required might be extracted to be measured. The means employed to obtain the scale development has been the in-depth interview (Glaser & Strauss, 1967; Eisenhardt, 1989)\(^9\). In this phase the gathering of data has indeed consisted in carrying out a number of in-depth interviews of researchers of 11 European institutions dealing with academic spin offs (3 of them as mother organizations, 8 as spin offs). On sampling the following criteria have been taken into account (Bardin, 1977):

- a) sample representativeness\(^10\);
- b) sample exhaustiveness;

\(^9\) *Scales and items* have been set according to the guidelines of Churchill (1979) and Gerbin & Anderson (1988).

\(^10\) The compliance of this requirement has been guaranteed by selecting enterprises having differing organizational features (turnover, \(n^o\) of employees, capital stock).
The in-depth interview, which is largely used in management research (Evrard et al., 1993), has been chosen as a means of investigation as it allows the interviewed to freely express their opinions on a set of topics submitted by the researcher (Bailey, 1994). In particular, the topics submitted to the managers have been the following:

- their description of the knowledge stratification process;
- their description of the inscription process;
- the effects of sharing practices in research workgroup on knowledge socialization and stratification;
- their description of the cross fertilisation process within the parent institution;
- their perception of a firm-specific know-how;
- the perception of the effects of holding or not an academic-specific knowledge;
- the perception about the possibility of setting up a spin off enterprise thanks to the know-how acquired.

Interviews as surveyed have been first read perfunctorily in order to get a general idea of the responses to the topics submitted. This process has allowed the identification of a series of relevant data which have then been grouped into categories (the sentences of the interviewed have been thoroughly analyzed for the underlying logical schemes to surface). The first part of the study has thus allowed the researchers to get to some conclusions about a researcher’s learning process of a script.

Before describing the phase of development of the scales and items which have marked the exploratory factor analysis, some general considerations are necessary. Generally speaking, literature has demonstrated that behavioural scripts consist in some basic repetitive actions performed by all the individuals concerned (Abelson, 1981). However, the sequence of actions in a script may vary depending on the individual. One of the objectives of the present study has been to check the possibility for a simple script (e.g. an operating procedure) of generating a complex one (the capacity of the researcher to reutilize the know-how acquired, including the tacit one, to start a new autonomous enterprise).

This process is even more interesting if the role of the mother institution encouraging the stratification of knowledge among its researchers is taken into account.

From the analysis of the interviews carried out, the research design and the relevant variables are easily outlined. First of all the script is generated by the knowledge of critical specific processes that can lead the researcher to a business idea (usually researchers have less managerial skills than product/process management

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11 An homogeneous set of data means that the same topic has been submitted to all the interviewed by the same surveying technique.
knowledge). Secondly, holding a script spontaneously urges the researcher to evaluate a possible change (as a matter of fact the process is usually gradual: at first the employee holding a script and aware of the script underlying relevance weighs the chance of exploiting the knowledge acquired while working with the parent institution to turn into an entrepreneur himself).

In-depth interviews carried out have been used to arrange an initial set of scales and items relative to the various constructs. Then the items have been revised and the irrelevant ones have been cancelled. The outcome has been an online questionnaire\textsuperscript{12} organized in 41 items.

As concerns the process of operationalization of variables, one of the critical choices has concerned the number of points of the measurement scale. In this study, in order to combine accuracy of data, with flexibility of the replies, differential semantic scales have been adopted ranging from 3 to 5 points (in literature these scales are considered easy to understand and employ, being “universal” and providing a satisfactory degree of facial validity (Bagozzi, 1994a)\textsuperscript{13}.

The interviewed invited to reply to the questionnaire via e-mail were given access to the web pages activated while data were automatically gathered by the

\textsuperscript{12} Data acquisition has been obtained through an ASP database to be filled in on http://www.maggioni.org/mq/uneng1.asp.

\textsuperscript{13} Bitner (1990) suggests to resort to direct observation for detecting the behavioural pattern of an employee within his organization (a similar stance is argued by Evrard et al. (1993), p. 128). As however direct observation is time-consuming and expensive (Evrard et al., 1993), it could not be applied to this research and instead a “method of sample calibration” has been opted for which joins the benefits of direct observation with the advantages provided by the employment of questionnaires. The method applied has required that script knowledge be measured against a calibration sample (in this case ten Italian high-tech enterprises, originating from spin offs). Taking as a reference the stratification of knowledge as well as the generation of the script in enterprises affected by spin off processes, script knowledge has been measured both through perceptive measurements and observed ones (perceptive measurements have been obtained through items concerning stratification processes of knowledge in employees and the reproduction of the script in a new enterprise, whereas the observed measurements have been obtained through the analysis of the knowledge as stratified by the employees as related to their functions and to the results of the spin offs). Next the convergence of the two measurements has been tested (as suggested by Heeler & Ray (1972, p. 362). This method resorts to quasi-experimentation and pursues the target of testing the relation between perceptive and observed measurements, verifying whether perceptions of individuals (obtained through a questionnaire) are reflected in their behaviour (surveyed through direct observation). At the end of this study, after submittal of the questionnaire, the calculation of the correlation between two undisclosed factors, knowledge of the script perceived and observed, has given a high coefficient $\phi$ ($=0.94$). The significant convergence of the two constructs has been guaranteed by the fact that at a 95\% confidence level (2 standard deviations) the $\phi$ range has resulted equal to $1.05<\phi<0.87$. As the interval contains the value 1, the two factors appear not separated (Bagozzi, 1994b). In other terms perceptive and observed measurements of knowledge converge, thus suggesting a substantial matching of the statements of the individuals involved in spin off processes and their actual behaviour.
database specifically arranged for. A special online section has also been devised where results of the interviews have been displayed as updated in real time by means of simple three-dimensional bar graphs, diagrams, pies, etc. The database and the online questionnaires have been linked to a simple statistical processor monitoring the progress of interviews in real time and providing an immediate empirical result via a user-friendly graphic display.

420 researchers of institutions involved in spin off processes (20% of which from spin off companies) have been invited to answer the questionnaire. The answering rate has been quite high, thus demonstrating the interest of the interviewed in the research (Average AR = 55%). As a whole 231 questionnaires have been returned to be analyzed.

Research hypotheses

The present research has first investigated the possible consequences of organizational learning on the employee. The spin off capability of favouring the transfer of firm specific knowledge as condensed in a script has been analyzed by formulating two basic hypothesis:

\[H1: Tacit knowledge stratification in academic communities of practice spurs the individual to a spontaneous process of cognitive script encoding (i.e. inscription process)\]

\[H2: Individuals that encoded a cognitive script thanks to an inscription process are very willing to create spin off enterprises\]

Statistical analysis and discussion

Exploratory Factor Analysis

Hypothesis have been tested by means of multivariate statistical analysis techniques (in the analyses reported the 13.0 version of SPSS software has been employed). In order to obtain relevant results the sample employed has been divided into two datasets: an exploratory dataset (n = 120) and a confirmatory dataset (n = 111). An exploratory factor analysis has been thus conducted for determining which scales might be relevant for devising the model and for testing the hypotheses. Cronbach Alpha analysis has showed a general consistency of the items selected (see Tab. 1). Items inconsistent with the model proposed have been then eliminated as well as those having a poor correlation with the other items measuring the same construct.

\[14\] Particularly, referring to the present research, the inscription process mentioned in H2 is an individual process but stemmed from a collective knowledge sharing (see H1).
Did you inscript your tacit knowledge?

On termination of the exploratory factor analysis the internal consistency of all the scales selected corresponded to a cut off loading point > 0.70 (Nunnally & Bernstein, 1994) (Tab. 1).

**Exploratory Factor Analysis**

<table>
<thead>
<tr>
<th>Scale/items</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tacit knowledge stratification (α=0.93)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) I used to share and exchange tacit knowledge by working in group</td>
<td>0.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) I regard knowledge sharing as main reason for tacit knowledge settling</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) I regard participation to working group as an important factor of tacit knowledge increase and improvement</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) I regard personal involvement in advanced projects as an important factor of tacit knowledge settling</td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) I regard personal development of common research as an important factor of tacit knowledge increase</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willingness to spin off (α=0.87)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) I regard exploitation of specific know how acquired as main reason for urging an individual to spin off</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) I regard technical know how and training as important factors for spurring individual to spin off</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) I regard personal contacts (developed during my work at the parent company) as an important factor in order to make individual willing to spin off</td>
<td>0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) I regard confidence in my business idea as main reason for urging an individual to spin off</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Some individuals in the organisation are more willing to promote spin off processes</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Some functions in the organisation are more willing to promote spin off processes</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive script acquisition (α=0.91)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) I learned and used behavioural schemas for my job at the parent organisation</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) I regard the schemas that I used for my job more complex than simply organizational routines</td>
<td>0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) I used for my job tools that, once learned, reduced my cognitive efforts</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) I learned and used behavioural schemas during my job that improved by using</td>
<td>0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) I improved my behavioural schemas by sharing my knowledge with other colleagues</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>3.20</td>
<td>2.87</td>
<td>5.45</td>
</tr>
<tr>
<td>Percent explained variance</td>
<td>9.4</td>
<td>8.3</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Tab. 1. *Exploratory Factor Analysis*

**Confirmatory model: test of the hypotheses and discussion of the empirical results**

The exploratory factor analysis performed has highlighted the relation between the scales and the items. The second phase of the empirical analysis has, instead, thoroughly deepened the scales obtained, to the purpose of testing the assumptions made. The confirmatory model has been applied to the whole sample (*confirmatory dataset*) as available (n = 111).

---

8 In brief the “tacit knowledge stratification” scale refers to the individual script summarizing the tacit knowledge stratified during his employment with the parent organization. The “cognitive script acquisition” deals with the encoding of the tacit knowledge acquired in a cognitive script. Likewise the positive correlation between the mentioned scales describe the inscription process. The above mentioned scales are described also by a number of other items. For briefness’ sake only the most relevant of them have been reported in Tab. 1.
The test of H1 and H2 hypotheses has been performed by means of a classic confirmatory model (test $\phi$). These choices perfectly comply with the indications thereon proposed by the relevant literature (Gerbin & Anderson, 1988).

On modelling, the fit ratios have showed satisfactory values and therefore the framework of observed variables as selected has not been changed$^{16}$. Results obtained have showed the reliability of any dimension of the model; at the same time also the composite reliability (a LISREL measurement, similar to the Cronbach Alpha) has resulted as generally high (Tab. 2). Lastly, the variance obtained for each dimension has generally resulted greater than 0.60, which means that variance was common to the indicators of each dimension (Fornell & Lacker, 1981)$^{17}$. Accordingly the model devised consists of two stages: a first one - (H1) – in which the individual improves and increases his personal knowledge by sharing tacit knowledge in academic communities of practice; moreover, he encodes it in a cognitive script (i.e. inscription process). A second stage - (H2) - in which the cognitive script holder becomes willing to turn himself in an entrepreneur within a spin off enterprise, probably because aware of the relevance of the knowledge encoded in his own scripts. Furthermore, H2 requests a specification. The knowledge encoded in cognitive scripts by spin off promoters should be considered “relevant” in order to develop their business idea; otherwise, they would not imagine to turn their research in a firm. This issue can be furthermore justified since in academic and research contexts it’s common that scientific knowledge likely to lead to a product (or to a process) at the bottom of a business idea. Then, our research framework can be finally outlined: the tacit knowledge stratification because of the participation of an individual to a community of practice (or to a workgroup) sums up in a cognitive script. Furthermore the holding of such “relevant” script generates a spontaneous entrepreneurial behaviour.

Generally academic institutions tend to encourage circulation of knowledge throughout the organizational framework to the purpose of favouring development and innovation. All that brings about an unavoidable increase of the tacit knowledge transfer among the operators of the academic institution. Our main research hypothesis is that individuals, by being exposed to that knowledge flow, spontaneously will manage their work by developing behavioural scripts aiming at reducing their cognitive efforts$^{18}$ (H1). This is just what we defined “inscription” process: once gained and improved his personal tacit knowledge thanks to the interaction with members of a community of practice, the individual encode it in a script that can help him to work “better”.

$^9$ Although $\chi^2$ has given high statistical values ($\chi^2 = 37.25$, $df = 110$, $P<.01$), other fit ratios have confirmed acceptability of the model (Tucker Lewis Index = 0.84; Comparative Fit Index = 0.91 (Bollen, 1989). The $\chi^2$ value is conditioned by the size of the sample selected.

$^{17}$ In this study for simplicity’s sake values relative to $\chi^2$ difference tests are omitted.

$^{18}$ Every implementation of a process require cognitive efforts that can be reduced through the learning and the use of cognitive scripts.
The confirmatory model therefore helps acknowledge the validity of the second hypothesis (H2) too: individuals that encoded a cognitive script thanks to an inscription process are very willing to create spin off enterprises. Thus it is easier in research laboratories where individuals are directly involved in critical processes that can originate business ideas. It is worth underlining here that the hypothesis H2 does not exclude the involvement of classic motivations for an individual to undertake an enterprise. The gist of the empirical analysis has been however to demonstrate a possible correlation between the holding of cognitive scripts and the willingness to spin off depending on the will of the newly-born entrepreneur to re-use critical knowledge.

The confirmatory model devised (Tab. 2) highlights the mentioned close relations, thus confirming the mentioned hypotheses (H1: tacit knowledge stratification, willingness to spin off $\Rightarrow \phi = 0.79$; H2: cognitive script acquisition, willingness to spin off $\Rightarrow \phi = 0.87$). And moreover demonstrating the attitude of the individual who has learnt and processed a script (that he believes to be at the bottom of a valid business idea) to turn himself into an entrepreneur, tracking the success of his research in the academic institution.

<table>
<thead>
<tr>
<th>$\phi$ estimates$^b$</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model's dimensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tacit knowledge stratification (1)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willingness to spin off (2)</td>
<td>0.79</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>(21.87)$^b$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive script acquisition (3)</td>
<td>0.87</td>
<td>0.72</td>
<td>1.00</td>
</tr>
<tr>
<td>(19.54)$^b$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td>1.28</td>
<td>1.47</td>
<td>1.83</td>
</tr>
<tr>
<td>Composite reliability</td>
<td>0.84</td>
<td>0.81</td>
<td>0.93</td>
</tr>
<tr>
<td>Variance extracted</td>
<td>0.48</td>
<td>0.62</td>
<td>0.55</td>
</tr>
</tbody>
</table>

$^a$ The first figure indicates the value of the $\phi$ coefficient. The second is the value of the $t$

$^b$ Relevant for $P < .01$

**Tab. 2. Confirmatory Model**

Conclusions

The above developments suggest that knowledge is closely dependent on the cognitive abilities of the actors who hold it, and that it cannot be separated from the communication process through which it is exchanged. This perspective helps to underline the cognitive and strategic implications of the transformation of knowledge and explores the conditions and the consequences of the transformation of knowledge from the individual to the collective level (and reciprocally). The concept of community enriches the organizational representation of knowledge-based activities. Our approach highlights the key role that research communities play in supporting the growth of science-driven industries. As the discussed
empirical analysis indicates, 'chunks' of typically tacit experiential knowledge, captured and organized in scripts, which scientists in such communities develop, provide these scientists with significant comparative advantages in developing the recreation of productive knowledge from the template site in spin-off firms. In fact, the cognitive script holder becomes willing to turn himself in an entrepreneur within a spin off enterprise, probably because aware of the relevance of the knowledge encoded in his own scripts. Further researches can be more focused on the "relevance" of those scripts for the developing of a business idea via spin off (in a knowledge re-use perspective). Moreover, they can point on how much does it weight holding such relevant scripts on spinning out decisions.

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Did you inscript your tacit knowledge?


A BUSINESS MODEL FOR TELEMONITORING SERVICES

Sietse J. Dijkstra
School of Information Sciences
Windesheim University of Professional Education
P.O. Box 10090, 8000 GB Zwolle, The Netherlands
S.Dijkstra@Windesheim.nl

Jan A. Jurriëns
Management, Logistics and ICT research group
Windesheim University of Professional Education
P.O. Box 10090, 8000 GB Zwolle, The Netherlands
JA.Jurriens@Windesheim.nl

Rob D. van der Mei
Department of Mathematics
De Boelelaan 1081a
1081 HV Amsterdam, The Netherlands
Mei@few.vu.nl

Abstract
In the next few decades one of the main problems to deal with in Western Europe is the aging of the population. More people will need healthcare services, while there are fewer people to provide these services. Telehomecare services like telemonitoring can provide a cost-effective means to save valuable healthcare service time by monitoring body functions from a distance. In this paper a business model is presented for implementing telemonitoring. This business model consists of a service domain, technical domain, organisation domain and financial domain. From this business model we can conclude that by using one flexible infrastructure for multiple telemonitoring services, infrastructure costs can be shared among multiple services. A partnership between homecare organization, central contact centre and supplier of monitoring devices and Wireless Sensor Network providers is required for telemonitoring provisioning.

1. Introduction
In the years to come the aging of the population in Western Europe will lead to a dramatic increase in the demand for specialized, and hence costly, healthcare services. For example in the Netherlands we see an increase of people above the age of sixty-five from 14% of the total population in 2005 to 19% percent in 2020 (Central Bureau of Statistics, 2006). On the other hand, within these statistics, an increase in the total healthcare population is not seen. Therefore pressure of healthcare professionals will be expected to rise. One of the chosen solutions to deal with the high costs of this aging population problem is to reduce the housing costs. Elderly people need to stay longer in their own house instead of going to a nursery home. In this context telehomecare services like telemonitoring and teleconsult can provide an outcome. It can help reduce the pressure for the healthcare professionals and increase the independency of the elderly patients. In this context the recent advances in broadband communication, wireless communication can offer affordable healthcare services that have not been fully explored before.
The subject of this paper is which telehomecare services are most viable and how can these services be implemented in such a way that it provides the most added value to the elderly patients and healthcare professionals. Telehomecare service offerings require many different parties to be involved, including for example network operators, medical experts, homecare organisations, central contact centres and service integrators. Implementation of these services is therefore highly complex and requires clear descriptions of services agreements, process descriptions and revenue sharing models. An extra complicating factor in offering these services is that elderly people are not familiar with technologies used within these services and should be introduced to the possibilities of new technologies. Creating business models for telehomecare services can help to get insight in making them commercially viable. In this paper, we propose a business model for telemonitoring services created by following the “Freeband Business Blueprint©”-method as suggested by Haaker et al (2004). For this method, two different creative sessions were held with healthcare- and IT-professionals. The information from these creative sessions combined with a literature study resulted in a business model.

The organization of the paper is as follows. In section 2 a description of business models and its use is given. Section 3 gives an explanation of the method used within our research. Section 4 gives a short summary of the creative sessions held. Section 5 describes the business model as an outcome of the creative sessions and the literature study. In section 6 the conclusions and recommendations are given and section 7 gives an overview of the references used.

2. Business model

Business models can help identifying and understanding the relevant elements in a specific domain and the relationships between these elements according to Osterwalder & Pigneur (2002). There are many different definitions of a business model. Within this paper the definition of Timmer (1998) is used, where a business model is defined as an architecture for the product, service, information flows, including a description of various business actors and their roles, a description of potential benefits for the various actors, and a description of the sources of revenue. Alt & Zimmerman (2001) suggest that there are a few common elements that turn up in definitions of business models which focus on the mission and strategy of the company. In our telemonitoring case we are more interested in how different organisations can work together in delivering a service and how technology can help in fulfilling the mission. Therefore we use the approach of Bouwman (2003) in which also a technology component is added and the focus lies on the customer value. It takes into account how organisation issues, technical and financial arrangements are needed to provide the customer value. The business model consists of four parts: customer value, technology-, organisational- and a financial arrangement.

The most important part of the business model is the determination of the customer value that is offered to the service. The new service should outperform existing services and offer added value comparing the existing services. The benefits of the new service should be higher than the total costs or sacrifices. For the service provisioning different specialised organisations can work together. Organizations are recognizing more and more the flexibility of alliances. Therefore we see organization networks arise. Every organisation within the network has its own goals and reasons why they participate. These goals and reasons should not conflict with each other. There are a lot of factors which have been driving companies into join forces; globalization, technological innovations, deregulation and cost efficiency (Duyster et al 2004). Value chain analyses gained popularity through the writings of Porter (1985) and
become a part of the business model. Business requirements as defined within the business model determine the information and communication infrastructure needed for the service provisioning and service management. However, choices made on the techniques used for the infrastructure can have effects on the value proposition and therefore on the business model itself. By describing within the business model which technology will be used, this is taken into account. All choices made on service delivery, technology have effect on the financial costs and benefits. With regard to financial arrangements there are basically three main issues: investments decisions, revenue models and pricing. For the success and viability of the business model it is important that the benefits are higher then the costs for all parties involved. A clear model which takes into account what the partitioning of income, investments, revenues and costs will be should satisfy all the parties.

3. Approach
To get viable business models we used the “Freeband Business Blueprint Method©” (FBBM) as a guiding principle. It is an instrument that can help organisations who want cooperatively develop and offer new innovative mobile ICT services. It can also be suitable for our purpose to get insight in which and how telehomecare services should be implemented. It integrates different techniques, like creative sessions, value webs and Cost-Benefit Analysis into one business model. For our technical domain we added a Modular Product Architecture for identifying functional requirements. The FBBM fits the four parts of the business model and consists of four domains as depicted in Figure 1.

![Figure 1: Business model framework](image)

The FFBM proceeds along three steps. The first step is a quick scan which consists of creative sessions with four to six participants. A creative session can be seen as a structured brainstorm session and consist of four domains: problem domain, idea domain, evaluation domain and selection domain. The goal of this creative session is to explore possible business models for telehomecare services. The problem domain is used to set the goal for the creative session. The idea domain is used to generate a lot of different ideas which serve the goal. Within the evaluation domain the ideas are evaluated and only the best ideas are kept. The
final selection domain is used to choose an answer to the goal which is can be further developed. In the second step the quick scan of the business model is evaluated and refined by using critical success factors. Further refinements and more details are added in the third step where the business model is evaluated and refined using critical design factors.

4. **Creative session**
Two separate creative sessions were held within our quick scan. The goal of the first session was defined as: “Which wireless services can help people to let them have a dignity stay for a long period in their own home”. It was attended by people of homecare organisation, ICT and healthcare consultancy organisation and a client group delegate. The wireless component of the services was left out in a later stadium of the session. This session resulted in a short description and initial functional requirements of four services to help people living longer in their own homes. Of these four services, telemonitoring was the most important and complex service to implement. It is a service which offers continually monitoring body functions of a patient. It consists of a monitoring device that measures body functions and sent them over to a central contact centre, where the data is analysed. The central contact centre can analyse the measurements, locate the patient and is able to send the right medical expert to the spot if needed. The second service is a relative simple communication service using not only audio communication, but also video. The goal of this service is to increase the social interaction of the person with its environment. For example, elderly people can talk and see their children and grandchildren, if they are less mobile. The third service uses the same technique, only now the video communication is used for consulting doctors, nurses and homecare professionals. The last service is a service that provides access to the home for homecare professionals without having a physical key of the door. This reduces the administration of authorisation and keys.

The second creative session used the conclusions of the first session as an input. The goal of this session was to identify requirements for telemonitoring, teleconsult, key-management service and how different parties can offer these services. This session was attended by an ICT manager of a local hospital, ICT city councillor of the local municipality, employees of a homecare organisation, ICT specialists and a client group delegate. From the conclusion of this session it became clear that homecare organisations can start implementing teleconsult services. Telemonitoring looks a promising service, but further development of the business model was needed from that point on. Within the next session the further development of the business model is presented as an outcome of the creative sessions, literature study and interviews with the working field.

5. **Business model for telemonitoring service**
In this section we propose a business model for telemonitoring service. The model consists of a service domain, technology domain, organisation domain, and finally, a financial domain. The creative sessions, literature study and interviews were used as an input for this business model.

5.1 **Service domain**
Telemonitoring can be defined as the use of information technology to monitor patients at a distance. Meystre (2005) suggests that the most promising application for telemonitoring is monitoring chronic illnesses such as cardiopulmonary disease, asthma, and heart failure in the home.
Although telemonitoring is still at an early developmental stage, the possibilities are promising. The main benefits of telemonitoring for the patients can be summarised as:

- Due to telemonitoring, medical experts can get an alarm earlier than without using telemonitoring. This can prevent serious disorders after an emergency.
- Neither patients nor the healthcare professionals need to travel for regular monitoring, comparing to existing monitoring services.
- The idea that medical experts get an alarm in case of an emergency can give patients a safe feeling.

Beside the benefits, also some sacrifices/costs to be made by the patients which come along with the telemonitoring services:

- Extra costs for infrastructure and service.
- Private information on body functions is sent over a public infrastructure and is shared by others.

Monitoring patients can be done in two ways: active and passive telemonitoring. In active telemonitoring the patient gives explicit permission to make contact with the central contact centre for sending measurements. This can only be the case if the frequency of sending information is relative low. Active telemonitoring has the advantage that privacy sensitive information is only sent with the permission of the patient. In this case the patient does not lose its privacy. If the patient doesn’t have a problem in sending body information to a central contact centre passive telemonitoring is possible. In passive telemonitoring the measurements are sent without interference of the patient. The main advantage is that in case of an emergency, when the patient cannot explicitly give permission, measurements are sent anyway and an alarm can be triggered. Another advantage is that with a relatively high frequency measurements can be sent to the contact centre without disturbing the patient. To reduce the sacrifice of privacy loss, patients can choose for active telemonitoring, where they decide when private information to medical experts is sent. Important requirement for passive telemonitoring is the security of transport and storage of privacy sensitive information about the patient. If this is taken care of, passive monitoring is preferable due to the higher benefits and therefore it will be used within this business model.

One of the results from the creative sessions is that successful telemonitoring services for a broad public should meet two requirements: they should be both highly reliable and cost-effective. In an emergency situation telemonitoring can provide up-to-date information, therefore it should be reliable. Not every potential patient will make use of telemonitoring services. In fact, it is more likely that only a relatively small group of patient with a life treating situation will choose for telemonitoring. The total-cost-of-service should be low due to a high adaptation rate by the group of potential clients (Bradford et al 2005). These two requirements seem to conflict. Although high reliability also results in relative low maintenance costs which leads to lower costs. Another conclusion of Bradford et al 2005 indicates that there is a negative correlation between the willingness to use telemedicine and the price to pay for the service.

To give an idea on what kind of telemedicine services can be offered, an overview is given of examples for telemonitoring services within subsection 5.1.1. Within subsection 5.1.2 and 5.1.3 two telemonitoring examples are described.
5.1.1 Telemonitoring services in general
Within table 1 an overview of examples of telemonitoring services is given. For all the services the frequency of the measurements are given, the client group disability, percentage of the total population within the Netherlands (Central Bureau of Statistics 2006) and if the measurements are sent actively of passively by the patient.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Frequency</th>
<th>Client group disability</th>
<th>% of the total population</th>
<th>Active / Passive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heartbeat</td>
<td>Continually</td>
<td>Heart disease</td>
<td>1.5%</td>
<td>Passive</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Every day</td>
<td>High blood pressure</td>
<td>9.9%</td>
<td>Active</td>
</tr>
<tr>
<td>Long volume</td>
<td>Every day</td>
<td>Asthma and COPD</td>
<td>7.3%</td>
<td>Active</td>
</tr>
<tr>
<td>Insulin in blood</td>
<td>Every day</td>
<td>Diabetic</td>
<td>3.1%</td>
<td>Active</td>
</tr>
<tr>
<td>Location</td>
<td>On request</td>
<td>Alzheimer</td>
<td>1.8%</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>When needed</td>
<td>Balance impairment and other geriatric disease</td>
<td>14 %</td>
<td>Passive</td>
</tr>
</tbody>
</table>

Table 1: Examples of measurements of body functions

Telemonitoring with a frequency on daily basis can be performed within the premises of the patient. This service does not require to work outside the premises. Heart rate monitoring, location monitoring and alarm monitoring on the other hand require also the possibility to measure and send information outside the patient’s premises. Therefore a flexible infrastructure is needed where functionality can be added or left out, depending on the needs of the patient and the needs of measurements.

5.1.2 Telemonitoring for COPD patients
Chronic Obstructive Pulmonary Disease (COPD) is a slowly progressive disease of the airways that is characterized by a gradual loss of lung function. COPD includes chronic bronchitis, chronic obstructive bronchitis, or emphysema, or combinations of these conditions. Within the Netherlands 7.3% of the population has Asthma or COPD (CBS, 2006). The diagnosis of COPD is confirmed by the presence of airway obstruction on testing with Spirometer. Once COPD has been diagnosed, recognising worsening signs and symptoms of COPD is an important part of managing your illness. Knowing when symptoms are changing is helpful so that treatment and other interventions can begin quickly. A Spirometer is a simple handheld that can be used within the house of the patient for recognising symptoms. Blowing forcefully into the tube provides a measure of air volume. The measurements can be sent over automatically to a monitoring environment where the measurements are compared with historical information. Important changes generate a trigger.

5.1.3 Telemonitoring for Heart and Vascular disease
A heart attack occurs when the supply of blood and oxygen to an area of heart muscle is blocked. Often, this blockage leads to irregular heartbeat or rhythm that causes a severe decrease in the pumping function of the heart and may bring about sudden death. If the blockage is not treated within a few hours, the affected heart muscle will die and be replaced by scar tissue. Within the Netherlands 1.5% of the population has a hearth or vascular disease (CBS, 2006). The challenge for heart patients is to keep the heartbeat under a certain level.
When a heart attack occurs, immediate reanimation is required. Telemonitoring can not prevent a heart attack, but measuring the heart rhythm can tell the patient if its heartbeat is above a certain threshold and if the heart rhythm is irregular an alarm message can be sent to a monitoring environment where further necessary actions are taken.

5.2 Technological domain
To get a complete image of the functionalities and technology that are needed for telemonitoring service a modular product architecture is used based on a functional refinement tree (Wieringa, 1996). Within this modal decomposition of all functionalities needed in the service is performed. The process of decomposition can be repeated until a level of atomic functions is obtained. The technical infrastructure is also decomposed into smaller atomic technical components in the same way as the functional decomposition. All atomic functions find their implementations within the technical infrastructure. This is reflected by the connection lines between the functions and technologies. In this way a complete overview of functions and implementation of these functions is given. Figure 2 gives the modular product architecture of the telemonitoring service. Only the service delivery functions are described in this architecture. The service management functions, marketing, customer services etc. are not taken into account.

![Modular product architecture](image)

All different telemonitoring services mentioned within the previous subsection 5.1.1 have three main functions: measuring, communication and monitoring. Measuring the body functions is where these services all starts. Table 1 indicates which body functions can be measured. Besides measuring the body functions there is a need for location determination for outside the home monitoring. The second function of telemonitoring is communicating between the measuring device and the central contact centre. The central contact centre monitors the patient. Communication consists of sending measurements, speech communication between the patient and the central contact centre when an alarm is given and sending meta-information like alarms, confirmations and cancellations. The last main function is monitoring and consists of storing the measurements within the patient’s personal file, analyzing the measurements by comparing it to the information within the patient’s file.
and giving an alarm if a threshold exceeds. Within active monitoring only the measurements are stored when the patient explicitly gives permission to send the data.

Technical implementation of these measurements can be done within a measuring device, using sensors. This can be done by placing sensors on the body of the patient. In the future new technologies like nanotechnology can be expected, which make it possible to measure more body functions within the body (Ferrante 2005). Within this business model they are left out. Location determination outside premises can be done using Global Positioning System (GPS). This gives an indication of the position of the patient with an accuracy of ten meters. Within the premises of the patient a wireless sensor network (WSN) can determine the position. The measuring device also needs a connection for the different communications functions. This connection is on the one hand a connection to a local area network (LAN) within the patient’s premises and on the other hand a connection to mobile network (MN) for communication outside the patient’s premises. The LAN can be implemented by using the same Wireless Sensor Network of for location determination within the premises, which is a low energy, low cost wireless network suitable within a home environment. Multiple telemonitoring services can be using one WSN. The advantage of this network is that the installation costs are relative low and the body functions can be measured and sent wireless from every place within the network range.

The mobile network needs to have GSM communication for speech communication and General Packet Radio Service (GPRS) or Universal Mobile Telecommunications System (UMTS) for data communication (Wac et al 2005). The choice between GPRS and UMTS depends on the data rate of the measurements needed. GPRS with a bandwidth of 114 Kbps is sufficient for most telemonitoring services, only telemonitoring services which send every couple of seconds a measurement requires UMTS with a minimal bandwidth of 144 Kbps. The local area network and mobile network are connected to a Wide Area Network (WAN). The WAN is used as an infrastructure for the communication to the central contact centre. The implementation of the WAN can be done using a virtual private network (VPN) on top of the Internet (Suomi & Tähkäpää 2003) or in some cases a normal fixed telephone infrastructure is sufficient for telemonitoring services with low data rates (Finkelstein et al 2004).

5.3 Organisation domain

The FFBM suggests creating a value web for modelling the organisational domain. A value web can be seen as a set of actors exchanging things of economic value with each other. An important concept in a value web is a value object. Such an object is a good, a service, a fee or a combination of these, which is of economic value for at least one actor. An actor is an entity perceived by itself and its environment as an independent economic and often legal entity. The goal of an actor is to make profit in case of an enterprise or to increase its economic utility in case of an end-consumer. Actors are related by value exchanges, which express the willingness of actors to exchange objects of economic value with each other (Gordijn & Tan 2003). Figure 3 shows a value web for telemonitoring services.

The two main actors within our business model are the patient and the homecare organisation. The homecare organisation offering care and cure services within home situations to the target group of telemonitoring services, is the natural organisation to offer telemonitoring service. They know the client group and telemonitoring services can be an extension to their current services. In return of the service a fee is requested from the patient.
The medical expert recommends the telemonitoring service if the medical situation requires telemonitoring. To get twenty-four hour monitoring from a distance the homecare organisation uses the service of a central contact centre. Central contact centres already have the infrastructure and the resources for twenty-four hour surveillance. They can enrich their portfolio by telemonitoring for homecare organisations in return of a fee. The contact centre requires telemonitoring software, connection to the patient’s files and contact information of medical experts in case of emergencies. An alarm can be given by the contact centre to the medical expert and to the homecare organisation depending of the urgency and needs of the situation. The telemonitoring service makes use of the infrastructure as described in the previous section. The providers of these infrastructures, which are the enablers of the service, are also placed within the value web. The homecare organisation gives a set of minimal requirements for the infrastructure for the specific telemonitoring service. This can consist of a mobile network, Internet connection and/or a normal phone line. Homecare organisations can give advice on providers to be used, but the patients arrange their own infrastructure. The advantage of this is the decrease of the costs for the total telemonitoring service and only infrastructure components needed for the service are used. Moreover, in some cases the patient already has parts of this infrastructure. In that case it is not needed to get an extra connection to that part of the infrastructure. Patients also can choose for using plain old telephone system instead of an Internet connection if the telemonitoring service requirements allow this. The specific infrastructures of the wireless sensor network and the measurement device are provided by the homecare organisation. These are specific equipments that in most cases can not be shared by other services then other telemonitoring services. If the patient wants to stop using the service, these equipments can be taken back by the homecare organisation and reused by a new customer of the homecare organisation.

5.4 Financial domain

Financial evaluation of telemedicine applications is required to provide decision makers in healthcare with appropriate information on financial costs and benefits. At the basic level, economic evaluation may include basic cost-benefit analysis (CBA) for all actors involved within the value web. From this analysis decisions can be made on which actors become partners in offering the telemonitoring service and which actors should invest. Partners are organisations that are connected through tight relationships and interdependencies considering risk sharing, solving common problems and acquiring access to complementary knowledge. Only investments decisions and a high level revenue model of the business model are discussed within this section. Pricing model are necessary for the valuation of the

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**Figure 3: Value web for telemonitoring services**

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**5.4 Financial domain**

Financial evaluation of telemedicine applications is required to provide decision makers in healthcare with appropriate information on financial costs and benefits. At the basic level, economic evaluation may include basic cost-benefit analysis (CBA) for all actors involved within the value web. From this analysis decisions can be made on which actors become partners in offering the telemonitoring service and which actors should invest. Partners are organisations that are connected through tight relationships and interdependencies considering risk sharing, solving common problems and acquiring access to complementary knowledge. Only investments decisions and a high level revenue model of the business model are discussed within this section. Pricing model are necessary for the valuation of the
organisational network but are left out of this paper; it requires extra market research, and financial cost/benefit analysis which are not performed.

Bradford et al (2005) investigated the willingness to pay for telemedicine, which shows that patients with chronic heart failure and patients with hypertensions are willing to pay for telemedicine. Between 30% and 50% of the hypertension group are willing to pay at least $20 per month for telemonitoring and for the chronic heart failure patients this is even higher. Assuming these figures will hold within Western-Europe a turnover of approximately 17 million\(^1\) dollar per year within the Netherlands can be expected for only chronic heart failure patients.

A cost based analyses is performed on a quality level for all the actors within the value web of the previous subsection and resulted in table 2. Two extra actors, insurance companies and government are added to this analysis. Although they don’t play a role in the service provisioning nor in the service management, they are indeed a party of interest to invest in telemonitoring. Telemonitoring can prevent health complications, due to adequate and quick actions of medical experts, therefore a reduction in healthcare costs can be realised. Insurance companies and government benefit from this reduction and are logical partners to invest in telemonitoring services.

<table>
<thead>
<tr>
<th>Actor within the value web</th>
<th>Benefits</th>
<th>Costs</th>
<th>Financial invest needed</th>
</tr>
</thead>
</table>
| Patient | ● Prevention of health complications  
● Monitoring without needing to travel  
● Safe feeling | ● Fee for telemonitoring service  
● Fees for different network access  
● Sharing privacy | - |
| Homecare organisation | ● Fee for the service  
● Customer relation | ● Service provisioning costs  
● Service management costs | Invest in service |
| Central Contact Centre | ● Contract with homecare organisation | ● Investments in monitoring equipment  
● 24 Hour medical surveillance | Invest in monitoring |
| Medical Expert | ● Better and quicker diagnosis  
● ‘On-time’ alarm | ● Analyse extra medical information | - |
| Mobile Network Provider | ● Extra revenues on data and speech communication | ● Minimal extra infrastructure costs | - |
| Internet Service Provider | ● Potential new customers | ● Minimal extra infrastructure costs | - |
| LAN and measuring device provider | ● Sell devices  
● Installation | ● Investments in new techniques for the infrastructure and measuring devices | R&D on new measuring techniques |
| Insurance companies and government | ● Prevention of health complications | ● Stimulation of telemonitoring projects | Invest in pilots |
As we saw, the homecare organisation is the most logical actor to offer these services and by offering these services they can generate new revenues and get a closer relation with the patient. Extra services can be offered to the clients by marketing techniques like cross-selling and up-selling. The central contact centre needs to invest in telemonitoring software and gets its benefits from the contract with the homecare organisations. This is a relative big investment in proportion to the risk been made, there for these investments can only be done in partnership with the homecare organisation. A close relation between these two actors is required to justify the risk for the central contact centre. Another actor which invests in the service is the provider of the measuring device and the wireless sensor network. A partnership with this actor can lead to lower risk of research and development (R&D) costs for the provider due to guaranteed sales of devices and wireless sensor network. Guaranteed sales of devices can result in price reduction for the homecare organisation. Mobile network provider and Internet Service Providers are not necessarily a partner within this service although they are interested parties and can benefit from these services. Their services are used when needed in the specific client situation and no extra investments are needed to offer the services. Table 2 indicates four actors invest in the service. The homecare organisation invests in service delivery, service management, marketing and sales. The central contact centres adjusts it infrastructure for telemonitoring services and creates a connection to the personal medical file. Wireless sensor network and measurement device provider invests in R&D of the devices and infrastructure. Together they can form a partnership. A part of the investments costs can be funded within the pilot phase. Revenues from the service can be shared to ratio of investment between the three partners.

6. Conclusions
In this paper we have proposed business model for telemonitoring services. Concluding from this business model we see that telemonitoring services can provide a cost-effective means to save valuable healthcare service time by monitoring body functions. To implement these services for a broad public they should be secure, reliable, cost effective. The functionality of the service should be flexible and adjustable to the clients needs. A technical infrastructure can be cost effect if it supports multiple telemonitoring services and functionalities can be added and removed. A partnership between homecare organization, central contact centre and supplier of measure devices and LAN infrastructure is required for the services provisioning. Health insurance companies and government can accelerate the time to market of these services by investing in pilot projects.

7. References

*Sietse J. Dijkstra MSc is lecturer and PhD-researcher at the School of Information Sciences at VU-Windesheim, Jan A. Jurriëns PhD is associate professor management at VU-Windesheim, Rob D. van der Mei PhD is senior staff member at the Centre for Mathematics and Computer Science and part-time professor at the Vrije Universiteit Amsterdam.*
USING KNOWLEDGE MANAGEMENT TO GAIN COMPETITIVE ADVANTAGE IN
THE TEXTILE AND APPAREL VALUE CHAIN:
A COMPARISON SMALL AND LARGE FIRMS

Paula Danskin Englis, Campbell School of Business, Berry College, Mount Berry, GA 30149
and NIKOS, University of Twente, pdanskin@berry.edu

Basil G. Englis, Campbell School of Business, Berry College, Mount Berry, GA 30149
benglis@berry.edu

Michael R. Solomon, 308 Spidle Hall, Auburn University, Auburn AL 36849
solommr@auburn.edu

Laura Valentine, Campbell School of Business, Berry College, Mount Berry, GA 30149
lvalentine@berry.edu

Nicole Bieak, 308 Spidle Hall, Auburn University, Auburn AL 36849 bieakni@auburn.edu

Seth Turner, Campbell School of Business, Berry College, Mount Berry, GA 30149
sturner@berry.edu
USING KNOWLEDGE MANAGEMENT TO GAIN COMPETITIVE ADVANTAGE IN THE TEXTILE AND APPAREL VALUE CHAIN: A COMPARISON SMALL AND LARGE FIRMS

ABSTRACT

The ability to store, capture, and disseminate knowledge within and across organizational boundaries has challenged managers for many years. However, as product lifecycles have decreased and environmental complexity and volatility have increased, the need to manage knowledge is intensifying, particularly across the value chain. Firms view knowledge and knowledge management as part of their strategic orientation. The difficulties of managing knowledge are faced by firms of all sizes. Low-cost strategies may emphasize knowledge that can be used to cut costs, lower prices, and shorten cycle times whereas differentiation strategies may emphasize knowledge that adds value to a product giving it unique characteristics that serve to differentiate it from the competition. This research examines the process of acquisition, retention, maintenance, and retrieval of knowledge both within the firm through organizational memory and across the value chain through knowledge management and compares these practices for small and large firms.

KNOWLEDGE AND KNOWLEDGE MANAGEMENT

Knowledge theories span over 30 years (Polyani, 1966), however, it is only recently that knowledge has become regarded as a valuable asset in corporate boardrooms. Knowledge acquisition has become a critical resource for creating and sustaining competitive advantage as the competitive environment continues to intensify (Hitt, Ireland, & Lee, 2000). As with other corporate assets, the processes surrounding creation and transfer of knowledge must be managed with significant insights in order to derive the most value from knowledge investments (Bhagat, Kedia, Harveston, & Triandis, 2002; Conner & Prahalad, 1996; Davenport & Prusak, 1998; Edvinsson & Malone, 1997; Stewart, 1997). The purpose of this research is to examine the significance of managing knowledge both within firm (internal knowledge) and across the value chain (external knowledge) for small and large firms. First, we review the literature on knowledge management systems and propose some hypothesis for internal and external knowledge management. Next, we present the data and measures and follow with the results. Discussion of the results follows and the paper closes with managerial implications, limitations, and suggestions for future research.

The quest to innovate through research and development is essential for firms to remain ahead of competitors. Indeed, many firms view the acquisition of new knowledge as a way to gain and maintain competitive advantage (Danskin, Englis, Solomon, Goldsmith and Davey, 2005). However, few firms fully realize the benefits from highly valued knowledge. Knowledge that is isolated in one department or in a specific segment of the value chain is not utilized to its full extent. New knowledge should be harnessed and managed through internal knowledge management systems that create learning opportunities for other departments or product areas within the firm. Internal knowledge management systems may provide platforms for further development of knowledge transfer to external partners. By implementing internal and external
knowledge management systems, firms can experience a greater competitive advantage and sustained success over a longer period of time.

**Types of Knowledge Management Systems**

There are two general types of knowledge management systems that firms use to provide a basis for renewing competitive advantage. Passive knowledge management systems (such as the EDI system used by Wal Mart) are distinguished by their orientation to the “present” and tend to be used with channel members such as suppliers to more closely schedule component deliveries, reduce cycle time, cut inventories, and decrease the overall costs of production based on current behaviour of buyers and sellers. In contrast, active knowledge management systems have a "future orientation" and tend to be used with channel members to add value to the product as it passes through value chain. Active knowledge management systems reap not only the benefits of reduced costs and cycle time but also develop valuable knowledge that anticipates of future buyer/seller behaviour (e.g. market back R&D). Proactive knowledge management systems do not simply enhance efficiency through time and cost savings. They also provide a way to link and leverage the “voice of the consumer” to all stages of product development, production and distribution through the value chain. While anecdotal evidence suggests that some firms are building knowledge management systems that include both active and passive systems to provide feedback loops throughout the value chain, there is no empirical research relating these developments to strategy, value-chain position, and firm performance.

**Knowledge Management Systems – Internal Processes**

The effectiveness of building knowledge within the firm depends on the firm’s ability to monitor and absorb newly acquired knowledge from many sources and integrate this knowledge into its existing knowledge base (Hamel, 1991; Hansen, Nohria, and Tierney, 1999). Internal knowledge management systems can also be thought of as organizational memory. Establishing organizational memory via knowledge management systems is an essential task before firms venture into knowledge sharing with value chain partners. Before developing knowledge management systems, businesses need to understand the process of organizational memory. As shown in Figure 1, this process is divided into four separate parts acquisition, retention, maintenance, and retrieval (Stein, 1995).

![Figure 1: Internal Organizational Memory](image-url)
As shown above, part of internal knowledge management involves organization memory. Acquisition and retention play key roles in this process. Acquisition involves both internal and external research and development. Innovation or new knowledge facilitates value added product development that leads to an increase in competitiveness. Retention of organizational knowledge typically involves developing processes, procedures, and systems. In this way, retention can be thought of as a codification process to create organizational memory. Some firms’ retention processes involve the use of databases that record knowledge for future use; whereas, other firms may have an organizational culture where knowledge is shared by informal mechanisms such as talking at the water cooler or the coffee pot. While informal networks retain knowledge at a higher rate than distributed information system, the knowledge is not easily maintained for future use. Retention is facilitated by three mechanisms. These mechanisms include schemas, scripts, and systems. The importance of harnessing internal knowledge cannot be underestimated. Small firms may lack the time, money, or other resources needed to develop knowledge retention systems. As firms grow larger, they generally build internal systems and structures to manage the flow of information across the firm. Therefore, we expect that smaller firms will have fewer resources to develop and establish internal knowledge management systems, particularly those that facilitate organizational memory.

Hypothesis 1: Large firms will have more developed organizational memory than smaller firms will.

A second part of internal knowledge management involves the role of maintenance and retrieval or organizational memory. Indeed, maintenance of knowledge is often overlooked when discussing organization memory; however, if knowledge is not properly maintained, information could become misconstrued or lost all together. When knowledge is stored in databases, maintenance is simple; however, when information is stored within informal networks using individual minds, the maintenance becomes complicated. This is especially true in employee turnover, when valuable knowledge leaves with the former employee and is not transferred back to new hires. Of particular importance is the role of experts. When experts leave the firm, they take their knowledge and their informal knowledge network with them, which can be damaging to firm competitiveness (Prahalad and Hamel, 1990). Retrieval of knowledge is one of the most important aspects of organizational memory. Managers should develop support mechanism, motivation, and rewards for knowledge sharing and retrieval in order to be successful. Individuals must be motivated in order to retrieve and communicate information. Ernst & Young, for example, evaluates and rewards its employees based on their contribution to the knowledge of the firm (Hansen, Nohria, and Tierney, 1999). A major problem within many organizations is the fact that employees view knowledge as a method of securing their jobs and are reluctant to share their knowledge. The retrieval across the firm of internal knowledge can facilitate the discovery and exploitation of opportunities. Internal knowledge may lead to a technological breakthrough that represents an opportunity despite its market applicability not being readily apparent (Abernathy and Utterback, 1978). This knowledge can also enhance a firm’s ability to effectively exploit an opportunity by, for example, determining the product’s optimal design to optimize functionality, cost, and reliability (Rosenberg, 1994) and ultimately the economic impact of exploiting the opportunity (McEvily and Chakravarthy, 2002). Therefore, the ability to retrieve internal knowledge provides a firm with the ability to rapidly
exploit opportunities, or to be able to respond quickly when competitors make advancements (Cohen and Levinthal, 1990).

From the above, we expect that larger firms with more resources will focus on internal knowledge systems and structures more than smaller firms. More developed internal knowledge management systems will enable people across the firm to more fully access internal knowledge for market applicability and new opportunities. Thus, the following hypothesis is offered.

Hypothesis 2: Organizational memory will be more dispersed in large firms than small firms.

Knowledge Management Systems – External Processes

External knowledge management systems are often comprised of internet based systems that link members of the value chain. On a functional level, external knowledge management systems are transparent and allow every member of the value chain to “see” the operations of every other member through production schedules, shipping schedules, ordering schedules, and inventory levels. At a strategic level, knowledge management systems when shared across the value chain bring the “voice of the consumer” very clearly into the process. This allows the entire value chain to view changing customer preferences. Early knowledge of changing consumer preferences creates opportunities for all members of the value chain to react almost immediately, thus reducing cycle time of product development and change.

External knowledge management has received increasing attention from the academic community (Andersen and Christensen, 2000; Bessant, 2004; Dyer and Singh, 1998; Dyer and Nobeoka, 2000; Håkansson, Havila and Pedersen, 1999; Sako, 1999; Hult, Ketchen and Slater, 2004; Wagner and Bukó, 2005.). Most research has been conceptual to date. For instance, Dyer and Singh (1998) suggest value chain relationships are significantly affected by learning and shared knowledge. Exceptions include case studies by Andersen and Christensen (2000) and Håkansson et al. (1999). The case studies show that firms tend to learn and share more knowledge when they are embedded in a network – such as a supply chain. Larger firms may have more structured systems that emphasize learning to tap into their knowledge networks. These external knowledge management systems can lower costs tremendously by increasing communication and eliminating steps in the manufacturing process that are either unnecessary or duplicated. For instance, Toyota uses this type of system to emphasize knowledge sharing with its supplier network (i.e., Kogut, 2000). Firms can gain significant benefits by integrating knowledge from external sources outside the firm (Dyer and Nobeoka, 2000; Kogut, 2000; Mohr and Sengupta, 2002). Value chain partners can also experience rapid learning by jumping onto another’s learning curve with particular processes or procedures such as Six Sigma Continuous Improvement. Knowledge sharing leads to increased quality and heightened customer perceptions of brand platforms. Such knowledge stores can be accessed through interorganizational relationships with customers, suppliers, and other bodies outside the company (Dyer and Singh, 1998; Madhok and Tallman, 1998). Schroeder, Bates and Junttila (2002) found that that external learning and knowledge transfer among the firms and their suppliers and customers is the strongest contributor to manufacturing performance in their empirical study of 164 manufacturing plants. Learning and sharing knowledge with suppliers play an important role in interfirm buyer-supplier relationships (Dyer and Singh, 1998; Sobrero and Roberts, 2002).
Suppliers may possess resources that complement the firm’s knowledge base which may generate positive externalities and allow the firm to capture spill over from its suppliers (Lorenzoni and Lipparini, 1999). Based on our review of the literature, we expect that the ability to establish an external knowledge management system to learn from the others in the value chain is likely to result in sustained competitive advantages for the firm. Based on our review of the literature, larger firms are more likely than smaller firms to focus on learning from value chain members.

**Hypothesis 3:** Larger firms are likely to have external knowledge management systems that emphasize learning more than smaller firms.

We expect that larger firms will also focus on developing external knowledge management systems that foster innovation with value chain partners more than smaller firms. Larger firms will be more likely to standardize practices, processes, and platforms among value chain partners. This drive for uniformity across the value chain increases knowledge sharing, cooperative developments, and the utilization of information captured from supply chain systems. The more developed the external knowledge management systems, the more likely the firm will learn from partners’ knowledge for market applicability and new opportunities. We expect that smaller firms will also focus on developing external knowledge management systems that foster entrepreneurship activities with value chain partners more than larger firms. Smaller firms are more likely to be entrepreneurially focused than larger firms and more flexible to take advantage of entrepreneurial opportunities. They are likely to adopt the latest supply chain technologies and may engage in higher risk projects. We expect larger firms will focus more on innovation and smaller firms will focus more on entrepreneurship.

**Hypothesis 4:** Larger firms are likely to have external knowledge management systems that emphasize innovation more than smaller firms.

**Hypothesis 5:** Smaller firms are likely to have external knowledge management systems that emphasize entrepreneurship more than larger firms.

**METHODOLOGY**

The goal of this research was to develop a descriptive framework and explore possible relationships among variables (Campbell & Stanley, 1963). The design selected was a non-experimental, static group comparison survey that is suitable for exploratory investigations where a phenomenon is described (Denzin, 1978).

**Sample**

To allow for maximum generalizability, a national sample of US firms participating in the apparel and textile industries was used. We chose this industry because it has come under severe international competition in the past decade and many low cost participants have moved operations overseas. We expected that firms in this industry would be forced to compete on other factors such as knowledge management. A U.S. national sample reduces any bias due to
economic variations in certain areas of the country. The sample was drawn from a database maintained by InfoUSA, an information services company located in Boston, MA. The database contained archival information on all firms in the sample and was used to compare the groups across broad categories (total sales, year the firm was founded, and number of employees) to test for non-response bias. The firms in the sample competed in many segments along the value chain of the US textile and apparel industries.

**Survey**

The major method of data gathering was an online survey. The survey was developed inductively using existing scales that were slightly modified for the specific purpose of this study. Pre-testing was used to check the questionnaire for comprehension and content validity. The instrument was evaluated by a group of academic experts and a practitioner from the National Council of Textile Organizations. This group reviewed and commented on issues such as clarity, order of questions, comprehensiveness and parsimony, and overall presentation of questionnaire. Efforts to increase the response rate were taken including offering to send respondents an executive summary of the results (Hinrichs, 1975) and the survey was emailed during a non-holiday period. The survey was also reviewed and approved by the Institutional Review Board at Berry College.

The survey was sent to members of the top management team of the firm since previous studies have found that top executives have relevant information about the strategy of the firm (Hambrick & Mason, 1984) and value chain management (Kobrin, 2000). Of the 310 people who work in textile and apparel industries to whom we sent the survey, 32 completed it resulting in a response rate of 10.32%. This sample was used to test the internal consistency of the measures. We are currently collecting more data using a larger sample of 2535 managers in the textile and apparel industry value chain. This study is in the field for data collection. Full results will be presented at the HTSF conference.

**Measures**

*Internal Knowledge Management*

Research on internal has focused on two main areas: Organizational memory level and organization memory dispersion. Before answering questions on internal knowledge management, respondents were first asked to think about a specific new project that they are familiar with that recently occurred within their firm. The respondents were asked to keep this project in mind when answering questions about internal knowledge. Organizational memory (ORGMEM) is defined as the amount of stored information or experience an organization has about a particular phenomenon (Moorman & Miner, 1997). It was measured by asking respondents to answer four questions on a seven point Likert scale, where 7 = strongly agree and 1 = strongly disagree. Respondents were asked, “Prior to the project, compared to other firms in our industry, my division had” “a great deal of knowledge about the category,” “a great deal of experience in the category,” “a great deal of familiarity with the category,” and “invested a great deal of R&D in this category.” The responses to these questions were subjected to exploratory factor analysis using principal component analysis and were tested for reliability through Cronbach’s alpha (Nunnally, 1978). All items loaded on the same factor (Eigenvalue = 2.82) and the reliability was consistent with previous studies (Cronbach alpha = .85, N = 32).
The second component of internal knowledge management is organizational memory dispersion (MEMDIS). Memory dispersion refers to the degree to which organizational memory is shared throughout the relevant organizational memory unit. If memory is widely shared, memory dispersion is high. If memory is not widely shared, memory dispersion is low. Respondents were asked to rate on a seven-point scale where “7 = high” and “1 = low” the degree of consensus among the people working on the project for the following new product areas: Product design, Brand name, Packaging, Promotional content, and product quality level. The responses to these questions were subjected to exploratory factor analysis using principal component analysis and were tested for reliability through Cronbach’s alpha (Nunnally, 1978). All items loaded on the same factor (Eigenvalue = 3.39) and the reliability was acceptable (Cronbach alpha = .88, N = 32).

External Knowledge Management

Three constructs pertaining to external knowledge management were adapted from (Hult, Ketchen, and Nichols, 2002). Supply Chain Innovativeness (SCINN) is continuous improvement through creativity and ingenuity (Hult, Ketchen, and Nichols, 2002). Generally, firms possessing innovativeness will strive to not only meet customer’s current needs, but also anticipate future needs. This construct was assessed on a seven point Likert scale where “1= strongly disagree” and “7= strongly agree.” Respondents were asked to click on the response that best indicates the extent of your agreement with each statement below: “Technical Innovation, based on research results, is readily accepted in the supply chain,” “We actively seek innovative supply chain ideas,” “Innovation is readily accepted in the supply chain process,” “People are not penalized for new supply chain ideas that do not work,” and “Innovation in our supply chain is encouraged.” The responses to these questions were subjected to exploratory factor analysis using principal component analysis and were tested for reliability through Cronbach’s alpha (Nunnally, 1978). All items loaded on the same factor (Eigenvalue =3.44) and the reliability was acceptable (Cronbach alpha = .88, N = 32).

The second external knowledge management is supply chain learning (SCLEARN). This is the generation of new insights that have the potential to change behaviour gained from other value chain members (Huber, 1991; Hult, Ketchen, and Nichols, 2002). This construct was assessed on a seven point Likert scale where “1= strongly disagree” and “7= strongly agree.” Respondents were asked to click on the response that best indicates the extent of your agreement four items were listed, “The sense around here is that employee learning is an investment, not an expense in the supply chain,” “The basic values of this supply chain process include learning as a key to improvement,” “Once we quit learning in the supply chain we endanger our future,” and “We agree that our ability to learn is the key to improvement in the supply chain process.” The responses to these questions were subjected to exploratory factor analysis using principal component analysis and were tested for reliability through Cronbach’s alpha (Nunnally, 1978). All items loaded on the same factor (Eigenvalue =3.20) and the reliability was acceptable (Cronbach alpha = .91, N = 32).

The third and final component of external knowledge management is supply chain entrepreneurship (SCENT). Entrepreneurship in the context of the supply chain is defined as pursuit of new market opportunities and the renewal of existing areas of an organization’s
operations (Hult, Ketchen, and Nichols, 2002). This construct was assessed on a seven point Likert scale where “1= strongly disagree” and “7= strongly agree.” Respondents were asked to click on the response that best indicates the extent of your agreement. There were five items: “We believe that wide-ranging acts are necessary to achieve our objectives in the value chain,” “We initiate actions to which other organizations respond.” “We are fast to introduce new administrative techniques and operating technologies in the supply chain,” “We have a strong proclivity for high risk projects in the supply chain,” and “We are bold in our efforts to maximize the probability of exploiting opportunities in the supply chain.” The responses to these questions were subjected to exploratory factor analysis using principal component analysis and were tested for reliability through Cronbach’s alpha (Nunnally, 1978). All items loaded on the same factor (Eigenvalue =2.78) and the reliability was acceptable (Cronbach alpha = .79, N = 32).

DATA ANALYSIS AND RESULTS

The first set of analysis involved examining a listwise correlation among all variables for the sample (n=32). In this research, correlation analysis showed several of the correlations were significant indicating that continuation of additional analyses was warranted. To test the hypotheses, a second set of analyses (t-tests) examined the mean differences for the involved variables between small and large firms. The sample was broken into two groups based on the average sales of the firms ($500,000). There were 18 small firms and 14 large firms.

Table 1 - Correlations

<table>
<thead>
<tr>
<th></th>
<th>ORGMEM</th>
<th>MEMDIS</th>
<th>SCINN</th>
<th>SCLEARN</th>
<th>SCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORGMEM</td>
<td></td>
<td>.400*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEMDIS</td>
<td>.068</td>
<td>.207</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCINN</td>
<td>-.044</td>
<td>.319</td>
<td>.617**</td>
<td></td>
<td>.195</td>
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<td>SCLEARN</td>
<td>.331</td>
<td>.035</td>
<td>.147</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCENT</td>
<td></td>
<td></td>
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</tbody>
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* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

The first set of hypotheses, H1 and H2, predicted differences between internal knowledge management practices of small and large firms competing in the textile and apparel value chain (organizational memory, organizational knowledge dispersion). Overall, the results provide support for these hypotheses regarding differences between small and large firms. Specifically, that larger firms will have more developed organizational memory than smaller firms (H1) will and that organizational memory will be more dispersed in larger firms than smaller firms did. The first hypothesis was supported. Our results show that organizational memory is significantly higher (p=.09) in larger firms (mean 13.57) than smaller firms (Mean 10.05). On the other hand, the second hypothesis was not supported. Although larger firms did have higher levels of organizational memory dispersion (mean 14.21), this was not significantly different than small firms (mean 12.33).
The second set of hypotheses (H3, H4, and H5) predicted differences between external knowledge management practices of small and large firms competing (supply chain innovation, supply chain learning and supply chain entrepreneurship). The results were mixed. In terms of supply chain learning, the results showed that larger firms did have higher levels of learning (mean 10.35 versus 8.61); however, these differences were not significant. Thus, H3 was not supported. For supply chain innovation, we proposed that larger firms will emphasize innovation more than small firms (H4). This hypothesis was supported. Our results show that supply chain innovation is significantly higher (p=.05) in larger firms (mean 18.71) than smaller firms (Mean 14.33). The final hypothesis was not supported. We proposed that smaller firms have higher levels of supply chain entrepreneurship. Results show that small firms’ level of entrepreneurship (mean 16.16) was not significantly different than large firms (mean 17.71).

DISCUSSION AND CONCLUSIONS

The difficulties of managing knowledge are faced by firms of all sizes. The purpose of this research was to examine knowledge management systems within the firm through organizational memory and outside the firm through innovation, learning, and entrepreneurship across the value chain. Specifically, we proposed that small firms manage knowledge differently than large firms. Our results show that large firms differ significantly from small firms in how they manage knowledge both internally and externally. Larger firms have significantly more developed organizational memory systems. However, small firms are just as good as their larger counterparts at dispersing organizational memory or sharing information with employees across the firm. Survey results indicate that smaller firms may not require formal knowledge structures to preserve knowledge. Small size may facilitate informal mechanisms such as meetings around the water cooler or around the coffee pot to share internal knowledge. Small firms also do not have as distinct hierarchal structures and the fierce departmental rivalries seen within large organizations that thwart system-less internal knowledge management.

In terms of external knowledge management, large firms emphasize supply chain innovation more than smaller firms. This may be due to increasing pressures in the textile and apparel value chain to cut cycle time. Larger firms generally coordinate longer portions of the value chain than smaller firms thus facing increased pressure to innovate and decrease cycle times among several firms. Large firms also tend to have more expertise specific to supply chains at their disposal and have significantly more capital to fund supply chain projects.

The goal of our research was to understand more about knowledge management and how the process of acquisition, retention, maintenance, and retrieval of knowledge both within the firm by improving organizational memory and across the value chain through knowledge management systems may help firms gain competitive advantage. This research will also help both small and large firms to examine and develop their knowledge management systems internally and externally. Internal systems create and sustain organizational memory. Organizational knowledge such as routines and processes are more easily stored whereas tacit knowledge of key individuals is much more difficult to codify. Organizational memory creates
opportunities to minimize knowledge isolation in functional departments and creates a greater base for tacit learning to be leveraged. Firms with robust organizational memories are less impacted when key personnel leave. External knowledge management systems bring value chain members closer together and add value to products (i.e., increased quality, customer perceptions of brand platforms) throughout the value chain. The opportunity for innovation increases as partners discover new possibilities or combinations from their input in the value chain processes. These opportunities may decrease costs of products or create innovative applications for mature products. The overall impact of knowledge management systems engaged across the value chain is to differentiate products from low cost substitutes in the marketplace and create sustainable competitive advantage for all partners.

Managerial Implications

From a managerial perspective, this study has several important implications. First, managers need to create and manage both internal and external knowledge management systems whether they are active or passive in nature. Internal systems are important as means to codify and create organizational memory. They also facilitate dispersion of knowledge across the firm giving employees a fuller picture of the firm’s knowledge base. While larger firms have more resources to create and store internal knowledge, small and large firms were equally good at dispersing knowledge across the firm. Managers should also manage knowledge-sharing in their supply chain (i.e., customers, suppliers and manufacturers, mills) by committing sufficient resources to setting up, maintaining and monitoring the knowledge-sharing network. Managers of larger firms may have more resources at their disposal to create these networks; but, managers of small firms can still benefit from supply chain networks. Our research shows that small firms are just as capable of innovating through the value chain as large firms and have similar levels of entrepreneurship gained through value chain interaction.

Limitations and Suggestions for Future Research

The results presented here are subject to some limitations. First and perhaps most important, the results were based on a very small sample aimed at a single industry. Data collection is not yet complete; therefore, we hope to confirm and extend these results with future analysis. A second limitation is the use of a single respondent per firm and we cannot ascertain from the responses whether any of the respondent firms are value chain partners. We recommend continued study of how knowledge is maintained and shared across the value chain. A longitudinal study of knowledge-sharing networks would be an excellent addition to this body of literature. We also looked only at differences in knowledge management systems in large and small firms and did not tie this information to firm performance. We propose that knowledge is strategically important and can be a source of competitive advantage. We recommend that further research be conducted to tie knowledge management systems to multiple forms of performance including both financial and cycle time performance implications.

Other areas that offer some interest include examining the role of absorptive capacity and firm culture (Cohen and Levinthal, 1990; Levinson and Asahi, 1995). It may also be interesting to investigate the use of knowledge management tools, shared communication vehicles, and the
facilitation of information technology as they may augment our understanding of internal knowledge management and external knowledge sharing.

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Growing Pains in Irish Biotechnology

Simon Gillespie and Dr. Colette Henry

Centre for Entrepreneurship Research,
Dundalk Institute of Technology,
Dublin Road, Dundalk,
Co Louth,
Ireland

Tel: +353-42-9370506/9370225; Fax: +353-42-9330944;

E-mail: simon.Gillespie@dkit.ie; colette.henry@dkit.ie

www.entrepreneurshipresearch.com
Abstract

Ireland’s biotechnology sector is primed for a revolution. Biotechnology, defined as “the application of knowledge of living organisms, and their components, to industrial products and processes” (Biotechnology Clusters, DTI, 1999), is now considered vital to Ireland future economic success (Harney, Enterprise Ireland, 2002). While exact figures are difficult to obtain, the EU estimates that by 2006 the biotechnology sector will be worth an estimated €250 billion, employing more than three million workers (Technology Foresight Report, 1999).

To date the sector has not been subjected to concerted academic scrutiny. However, a number of recent studies have begun to investigate the sector. These studies have examined a range of issues, including, the impact of policy tools on the formation of new biotechnology firms in Taiwan (Hsu, Shyu and Tzeng, 2005) and reforms in the biotechnology sector undertaken in Japan (Lynn and Kishida, 2004). A core objective in the Government’s biotechnology strategy is to stimulate growth and development among Ireland’s emerging, indigenous biotechnology sector (Enterprise Ireland 2002). Currently, there are less than 50 indigenous bio-enterprises in Ireland, most are micro companies and at an early stage of development. Furthermore, due to the nature of their activities, most bio-enterprises do not generate any profits in the early years, even bio-companies that have some revenue, tend to invest the bulk of their turnover in long-term product development.

By way of strengthening our understanding of this important area, this paper provides an analysis of the state of the biotechnology sector in Ireland. In contrast to its competition, Ireland as a nation was relatively late out of the starting blocks in the race to the forefront of the biotechnology world markets.

To lessen the gap between the pioneering and fully developed world leaders in biotechnology, the Irish government prioritised the biotechnology sector as an area for increased development together with major funding programmes into three vital areas, attracting overseas biotechnology companies, increasing the levels of applied research funding and creating and developing indigenous biotechnology start-ups.

The paper will aim to provide an insight into the biotechnology sector and the allocation of government investment in this potentially lucrative market both domestically and in a global arena. The paper will try and evaluate if the indigenous companies are allocated the necessary resources to compete globally, as well as assessing the strategies and challenges facing the sector presently and in the future.

There are currently 60 biotechnology-based companies on the island of Ireland. 42 of these companies are indigenous and 18 are multinational corporations. Of these 60 firms 40 are involved in biotechnological research and or processes. These include companies involved in biopharmaceutical discovery and manufacturing, diagnostics, pharmaceutical services, bioenvironmental technology and agri-food technologies. They include a mix of indigenous and multi-national companies.
This paper will examine the Irish biotechnology sector in relation to the development and funding, as well as what strategies are in place presently and future strategies. The paper will then look at investments in indigenous companies and venture capitalism within the industry through and the examination of government policies towards the industry. Also bio-Ireland funding and all the forms of financing used in the industry and how the SFI allocates its funding and resources in the indigenous biotechnology sector.

The paper will conclude with some present challenges facing the industry and look at possible future issues which the Irish biotechnology sector may face in its quest for an increasing share in the global market, as well as the critical role the governments agencies will play in these challenges.
Introduction

Biotechnology is now identified as a key growth sector in Ireland's portfolio of economically successful industries (Technology Foresight Ireland Report, 1999). Defined as the “application of scientific and engineering principles to the processing of material by biological agents” (Forfas Report, 1999), biotechnology is fundamentally a facilitating technology, pertinent to every aspect of daily life through healthcare, food and agriculture as well as pharmaceutical, chemical and environmental procedures and processes.

Given the importance of the pharmaceuticals, healthcare, agriculture and food processing industries to the Irish economy, it is of the utmost importance that the Irish market embraces and develops a strong and sustainable biotechnology sector to keep up and eventually spearhead global developments in this dynamic and expanding area.

By 2005, it is estimated that the biotechnology sector will generate €250 billion and account for over 3 million jobs within the member states of the European Union (Biotechnology Foresight Ireland 2002–2005 estimates). Ireland, Ireland was recognised among the top 25 global locations for biotechnology in “Beyond Borders” (Ernst & Young – Global Biotechnology Report 2002). In contrast to Ireland’s position in this report, is the stage in which Ireland’s indigenous biotechnology sector is presently at.

In stark contrast to the Ernst & Young report from 2002, the Irish indigenous biotechnology sector is in the relatively early stages of development. There are currently 60 biotechnology-based companies on the island of Ireland, 42 of which are indigenous and 18 of which are multinational corporations. Of these 60 firms 40 are involved in biotechnological research or processes. These include companies involved in biopharmaceutical discovery and manufacturing, diagnostics, pharmaceutical services, bioenvironmental technology and agri-food technologies.

These sectors along with the Integrated Communications Technology sector are now key industries prioritised by the Irish government for development and further investment, through structured research and development assistance programmes.
Research Context

The Emergence of Biotechnology in Ireland

When the global biotechnology sector was in its infancy and predominantly occupied by research and development during the 1980s and early 1990s, the idea of Irish economy joining such an industry was implausible on several levels. An Irish biotechnology sector didn’t exist during that period because the economy was in recession, poor infrastructural resources, and stealth taxes with no investment incentives, there were unfavourable levels of inflation as well as the “brain drain” of the 1980s. As indicated above, the Irish government was in no position to support or fund any initial concept of developing such a new and unknown sector.

From the mid 1990s onwards, the economical climate of the country began to change. Entrepreneurial competence was rewarded and Irish industry as a whole was growing at unprecedented rates. Towards the late 1990s, the Irish economy was well positioned with both the appropriate economic climate and finances to embrace this relatively new and dynamic industry. Ireland, with its improving infrastructure and increasing capital investment allocation to fund a potentially beneficial sector to its ever growing knowledge-based economy, was now ready to get involved with the biotechnology sector on a global level.

This turnaround in the Irish way of thinking was in part due to Forfas identifying the Biotechnology sector as a strategic input to enabling Ireland’s future industrial development plan (Forfas 1996 – A strategy for enterprise in Ireland in the 21st Century). After the publication of the Forfas report, in the late 1990’s the Irish government finally put in place a “Biotechnology Strategy”. Although the strategy was criticised to a degree in the subsequent publication of the Technology Foresight Ireland Report in 1999, criticising the poorly funded science bases and recommending vast improvement in research and development of new companies and existing companies, the path towards biotechnology was well and truly established.

At the time of this publication, Ireland was far from being identified as a centre for biotechnology. After Greece, Ireland’s investment in government supported R&D was less than 1% of total government expenditure. The overall configuration of the Irish biotechnology research programme was weak and Irish biotechnology graduates were emigrating to more sustainable biotechnology industries around the world. In the area of commercialising the Indigenous biotechnology sector, little funding was allocated to start-up companies.

“Unless investment does occur, Ireland will not only fail to benefit from the new biotechnology in terms of a large number of new, high quality, high added value jobs, but many existing jobs in the pharmaceutical and chemical industries, the food and drink industries and in agriculture will be jeopardised” (Technology Foresight Ireland Report, 1999 pg.6)

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1 Forfas - the Irish national policy advisory board for enterprise, trade, science, technology and innovation
2 European Report on S&T indicators, 1997
The Technology Foresight Ireland Report in 1999 report argued that for a bio-industry to succeed in Ireland, strong collaborations between the government, universities and industry were fundamental. The report put forward a number of recommendations, which included:

- The development of a quality R&D programme to foster “leading edge” research
- Additional focus on the commercialisation of research output through Biosearch Ireland
- Developing imaginative schemes to foster an indigenous industry while also attracting foreign investors
- The establishment of the Irish Biotechnology Start-up Fund, investing in biotech companies in the early stages of development
- Putting in place a communications strategy to increase public awareness and participation, information, communication and confidence in biotechnology

Through further research into the feasibility of a sustainable biotechnological sector in Ireland with the potential to expand into a global player, the Irish government acknowledged two issues, which could impinge on these potential successes and advancements in the sector. The issues integrated; the need to address public concerns involving modern biotechnology and ensuring an adequate science base in Ireland.

To deal with the issue of public concern and lack of knowledge towards biotechnology, the Irish council for Science Technology & Innovation produced a report in 2005 highlighting the issues involved with the negative coverage of the field of biotechnology was receiving through, for example, the portrayal of the genetic engineering sector and how this was effecting the public perception of the biotechnology sector as a whole. This was highlighted in the Eurobarometer survey carried out in 1999. The report observed the public’s poor understanding of the subject and called for open, neutral, up-to-date information to be readily available to the public.

With the help of the report published in 2003 called “Building Ireland’s Knowledge Economy, The Irish Action Plan for Promoting Investment in R&D to 2010”, the government set about finding a solution to the problem of building an adequate science base in the country. The report established the presence of a sizeable gap between the requirement and actual availability of skills necessary to build biotechnology clusters in Ireland. The report went on to resolve that the future growth of an Irish Biotechnological sector, would be determined by three resolute factors, firstly scientific advances, secondly the ability of firms to find commercially viable ways to apply this new knowledge and finally the competitiveness of Ireland as a location for the undertaking of basic research together with its commercialisation prospects.

The government needed to invest in producing a skilled labour force in this sector and also in the promotion and development of the sector to develop it into a world-renowned nation for Biotechnology. This, together with the establishment of the Science Foundation of Ireland in 1999, coupled with the unveiling of plans for capital
investment and the allocation of necessary resources, further develop and improve Ireland’s position as a successful and innovative knowledge-based economy. The issue regarding the falling numbers enrolling in science-based courses at third level was also highlighted in the report. The report stated that:

“Ireland must increase the supply of science-related skills in the economy if the biotechnology sector is to realise its full potential over the next seven years.”

(Building Ireland’s Knowledge Economy, The Irish Action Plan for Promoting Investment in R&D to 2010)

The report concluded that Irish universities must gradually decrease their dependence on public funding and become more entrepreneurial and enterprising. This would involve prioritising the needs of the enterprise sector together with using the scarce resources at hand to their advantage, preferably developing a source of income generation to each 3rd level institution. The report finished with the open idea that more funding for the science and biotechnology sectors was required, to reduce the gap between the supply and demand of skilled individuals in the biotechnology sector.

The Role of the Government
Over the past number of years the government has undertaken several high profile funding and development programmes to promote biotechnology. The establishment of the National Biotechnology Programme in 1987, which aimed to develop commercially viable biotechnological research in Irish universities, led to the creation of BioResearch Ireland. This was an externally contracted research organisation employed to explore the concept of commercialising existing biotechnology and developing the expertise and infrastructure necessary to facilitate biotechnology in Ireland.

BioResearch Ireland played a pivotal role in transforming 3rd level research information into practicable industry information. BioResearch Ireland’s exact objective is “to create start-up companies based on new technologies”.

The main task of the Science Foundation Ireland (SFI) is to develop and promote the range and value of biotechnological research in Ireland, through funding and development programmes.

Numerous reports strongly indicate that enterprises which perform research and development are more likely to grow and expand as well as provide higher quality and better paid employment. Between 2000 – 2006, the government allocated €648 million to the SFI, for research and development.

The SFI’s research and development funding increased by €58.4 million to €348.4 million in 2002. This increase was broken down into €13.9 million to 3rd level research, €32.7 million directly to the Science Foundation of Ireland and €8.5 million increase to Teagasc’s funding allocation. In 2005 SFI allocated €170 million to biotechnology. The Chart also shows how the funding was broken down and deciphered. The biotechnology sector in Ireland prospects were also enhanced with

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1 SFI- Government agency which builds and strengthens scientific and engineering research through grant aid
2 Kearns and Ruane, 2001
3 Teagasc- The Irish agriculture and food development authority
the help of government agencies such as Enterprise Ireland, the government agency assigned to supporting and developing indigenous industry, which launched a biotechnology strategy to initiate start-ups and help develop them into viable businesses. Enterprise Ireland also launched the first dedicated Biotechnology and Life Sciences Fund in Ireland with an investment of €15 million. Another government agency, the IDA\(^6\), supports growth within the foreign-owned manufacturing and services industries, and also promotes Ireland as a location for foreign investment for overseas multinational science and pharmaceutical companies.

**Prioritising The Biotechnology Sector in Ireland**

Biotechnology is now fulfilling its promise to become one of the key sectors in the creation of a high-tech research and industrial base in Ireland and is primed for growth. According to Michael Ahern T.D., Minister for Trade and Commerce:

> “The Irish Government is committed to a pro-business, pro-science environment to transform Irish Industry. It is making an unprecedented level of investment in science and technology to create a vibrant and well-supported biotechnology research community, giving a substantial resource for technology solutions and the basis for a stream of technology-based start-ups” (Michael Ahern T.D., Minister for Trade and Commerce).

The biotechnology sector in Ireland, both north and south, is beginning to blossom. On the Island there are 60 companies large and small, focusing on a diverse number of areas. In total they employ over 4000 people and although nearly sixty percent of these jobs are with multinationals, there is an increasing trend in the formation of indigenous companies. With the Biotechnology strategy Enterprise Ireland launched in 2002 organisational resources were integrated to deliver upon the targets set out in the plan.

New venture capital funds appear to be freer flowing in the last couple of years than in the previous decade, with venture capitalists focusing on investing in indigenous start-ups. A recent study (Mapping the Bio-Island, 2004) by the north/South trade and business development body, Intertrade Ireland, reports that twenty-five of the biotechnology companies “originated as spin-offs from university research”.

Dr Ena Prosser, who was appointed the Director of BioResearch Ireland, believes that support for academic research is key to the growth of indigenous biotech companies.

> “We need to engage our universities with industrial growth and the knowledge economy. Biotech, like software and electronics is one of the key levers to drive our economy and the investments by the Higher Education Authority and Science foundation of Ireland are key to developing a robust stream of entrepreneurs, ideas and trained employees in the future.” (Dr Ena Prosser- Director of BioResearch Ireland, 2003)

\(^6\) IDA- Irish state industrial development agency
Funding and Investment

Irish biotechnology at present is benefiting from combined funding of more than €1 billion from the SFI, Enterprise Ireland, the Higher Education Authority, the Health Research Board and the European Union. The majority of this investment is aimed at improving our research and development base, which is vital to strong growth in the sector.

Since 2003, dedicated incubation space for biotechnology start-ups has doubled. The need for laboratory space was identified because of the different requirements between the life sciences and areas like software. Over €4 million has been invested to date by Enterprise Ireland on the provision of wet-lab facilities in Irish third level institutions. When all of these facilities are fully operational, there will be bio-incubation space and support for up to 15 companies. The bio-incubator programme is another element of the Enterprise Ireland strategy “Building Biotech Businesses” designed to fast track opportunities to business. Ireland may have come relatively late to the biotech table, but increased funding for life sciences research is now resulting in more high tech commercial opportunities.

Under the National Development Plan 2000-2006 the government has committed €2.5 billion to research, technological development and innovation. Of this, some €605 million has been dedicated to the programme of Research in Third Level Institutions, from which funding was provided for the National Centre for Sensor Research. In 2005 the funding grew to €131 million, establishing university-based centres of excellence with significant levels of industrial development.

The biotechnology sector in Ireland is in the top three sectors for attracting venture capitalist funding in Ireland. In a survey carried out in 2004, 15% of venture capitalists interviewed identified biotechnology as a sector in which they would be likely to invest. When the same question was put to the banks, the banks stated that only 5% of their funding is allocated to the biotechnology sector. The state agencies funding allocation only gives the biotechnology sector 5% of its total funding also.

Even though the Irish Biotechnology sector is still in its early stages of development, is showing very positive signs for success. In the Intertrade report 2003. There are 60 indigenous biotech companies and at least another 4 start-ups preparing for launch. Their activities range from developing new methods of diagnosing and treating disease to products that assist in remedying mean environmental damage and prevention of such issues. What differentiates the biotechnology industry from others are the longer lead times involved in product and services development, which force some biotechnology companies to look at alternative sources of finance such as venture capitalism. In their early stages of development, biotechnology firms have to look beyond debt, venture capital and equity, all of which are common sources of finance in this sector. Some biotechnology firms even look to innovate deal structures to ensure a flow of funds as they commercialise their research.

Traditionally the average EU member states spend on R&D has fallen behind their US counterparts with the Irish R&D expenditure behind the EU average. The SFI is trying...
to redress this imbalance, with its allocation of €634 million to be invested in research between 2003-2006. SFI’s goal is to attract academic researchers that can generate new knowledge and technologies in this sector. The long-term goal of this investment is to filter through to campus companies that are developing and commercialising technologies developed in academia.

The venture capital options open to biotechnology companies in Ireland has improved, with the establishment of two Enterprise Ireland backed biotech funds by Seroba and Growcorp. Overseas Venture Capitalists are also showing an interest in the Irish Biotechnology sector, and particularly in companies at the later stages of their development processes. According to the Irish Venture Capital Association, for every €1 million invested by local funders, overseas investors in the biotechnology sector invest €2 million. Seroba BioVentures manages the Irish Biosciences Venture Capital Fund (IBVCF), Ireland’s first exclusively dedicated life science fund. Seroba launched a €20 million IBVCF in February 2002. It provides funding for promising new ventures from emerging companies as well as from third level institutions.

As the costs and timeframes involved in developing new technologies and products increase, biotechnology multinationals are outsourcing research projects to smaller biotechnology firms and indigenous Irish firms are in a position to benefit from these practices. All these schemes are assisting the development of a diverse and innovative Irish biotechnology sector. The only drawback to this is that more scientists of the necessary calibre are needed to develop the biotechnology incubators into an integrated national structure.

Seroba BioVentures funds various biotechnology companies with a large portfolio, which includes:

- AGI Therapeutics Ltd, with an investment of €9.5 million together with a syndicate of investors.
- Alimentary Health Ltd, Seroba has invested €1.3 million with Enterprise Ireland.
- Deerac Fluidics Ltd has received funding to the value of €2.8 million from Seroba and an Irish syndicate of investors.
- Diabetica Ltd, received seed funding from Seroba
- Eclipse Clinical Technologies, received €2.91 million from Seroba as well as from Irish investors.
- Opsona Therapeutics, received part of its €6.25 million in funding from Seroba.
- TriMed Research Inc, received €5 million from Seroba

A private venture capitalist firm called Growcorp was set up in Ireland recently. It is an integrated bioscience investment, advisory and incubation company, which delivers the resources to give a new biotechnology company a head start it needs to survive in this aggressive marketplace. Growcorp was the first private company in Ireland with an investment fund targeted specifically at the biotechnology sector with the help of the European Bioscience Fund. Growcorp invests at early stages of biotechnology companies with amounts up to €1.27 million, as well as leading syndicates with funds in excess of €5 million for more advanced businesses. Growcorp works with entrepreneurs to get their business from start-up to commercial
reality with services from strategy optimisation to fund-raising and team building advice. Growcorp’s portfolio includes biotechnology companies such as:

- Fluorocap
- Gas Sensor Solutions Ltd
- Merrion Biopharma Ltd
- NEUtekBio Ltd
- Orakine Ltd
- Pharmatrin Ltd

The Science Foundation of Ireland (SFI) was established to facilitate and award government funding in the area of research in biotechnology. The SFI invests in academic researchers and research teams to innovate and generate new knowledge, leading-edge technologies and competitive enterprises. SFI invests with a strategic outlook and lends its expertise and knowledge to developing companies and individuals either through research or practical aspects of their studies. The SFI now funds over 80 researchers and has commitments of over €170 million. It indirectly employs 550 plus life-science researchers in Ireland.

To complement the SFI’s work, Enterprise Ireland has launched its Biotechnology Strategy, with the target of increasing the number of Irish Biotechnology companies to 60 by 2006 and 130 by 2010. Together with sales growth of €230 million in 2006 and €635 million by 2010. These projections are expected to increase employment in this sector to 5000 staff.

**The evident Growing Pains in Irish Biotechnology**

The universal problem for newly established biotechnology businesses is the mismatch between early stage needs, and the resources, both human and financial, available to meet those needs. In the Enterprise, Trade and Employment Report on Business failure (2001), stated that 33% of businesses fail within the first 4 years of operation. Within the biotechnology sector, the failure rate is much higher because on top of the normal reasons for failure are issues such as internal and external economies of scale as well as longer product development lead times.

Other issues, such as access to funding, growth capital, investment and commercialisation of bio-research are critical obstacles to overcome in order for biotechnology companies to grow and prosper in this demanding global marketplace.

- **Lack of access to funding and growth capital**
  
  Research indicates that access to funding particularly venture capital funding is an issue for biotechnology companies, which is slowly becoming more accessible as the industry gains more recognition through its development and expansion. One of the main barriers to venture capital funding in biotechnology arises from the unique feature of the sector. Due to the long-term development of products and technologies, which is an extremely costly and complex process with a lot of uncertainties appended. To add to this funders and investors have also been put off by the small size of most biotechnology companies. As already indicated there are very small numbers of start-up companies being allocated funding by banks and venture capitalists. While investors are slowly coming around to the idea that investing in
biotechnology is beginning to become acceptable and competent. On the opposite side of the coin, biotechnology ventures have traditionally had a high failure rate. According to Harding and Lissenburgh (2000), it is estimated that for every 100-biotechnology research ideas, only one is likely to have any commercial potential.

From an investment standpoint, biotechnology is a high-risk activity, both from a cash flow and lifespan perspective. In terms of Irish Biotechnology, accessing venture capital funding is a major obstacle and issue because of both risk and the newness of the industry in terms of other well-established sectors. While venture capital funding in Ireland has increased significantly in recent years (Henry et al, 2004), funding is still concentrated in the ICT market. In 2002, the government announced Irelands first venture capital fund solely to the biotechnology sector under the management of Seroba with a fund of €25 million and to date has completed a first round of funding of €15 million.

While such initiatives are welcomed, most active investment houses, banks or state agencies require a good knowledge of the industries in which they are being asked to invest. This issue, together with the relatively innovative and dynamic temperament of the biotechnology sector, leaves it a difficult sector to become involved in from a funding perspective. This is also amalgamated with research that shows that awareness of venture capital firms on the part of the entrepreneurs is low, and this is where specialist advisors need to be brought in to guide and advise the proposals to the venture capitalists.

• **The Investment and Commercialisation of Bio-Research and Development**

It is generally accepted that research capacity is the key issue for the long-term development of the biotechnology industry. Since 1994, the Irish government has increased the level of investment in R&D five-fold from €500 million between 1994-1999 to €2.5 billion between 2000-2006 under the national development plan. Conversely, Ireland invests 1.4% of GNP into R&D, while the UK invests 1.84% of GNP. According to a recent report, this proportion of resource allocation needs to be raised significantly to 2.5% of GNP to ensure a more sustainable economic environment for this island nation to maintain its competitiveness in the global market place.

In addition to this report, a number of papers have been published concerning the commercialisation process involved in biotechnology in third level institutions in Ireland, have identified several weaknesses in the current system and economic climate. An Enterprise Strategy Group (ESG) survey (2004), profiled the current status of commercialisation among Irelands R&D institutions, identified a number of serious weaknesses in the commercialisation process. The report commissioned by Intertrade Ireland in 2002, found that many of the staff involved in the commercialisation process lacked the skills necessary to successfully transfer research into commercial products and services. The report identified the following weaknesses:

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9 Based on US research, Forfas Report, 1999
10 Building Ireland’s Knowledge Economy - 2004
- Low number of staff involved in commercialisation
- Inexperienced and under qualified staff
- Time dedicated to other duties performed by commercialisation staff
- Limited budgets for commercialisation

**Some of the Key Findings**
The report concluded by stating that, in order for commercialisation to be improved in Ireland, the individual institutions would need to develop a clearer policy commitment to the importance of the commercialisation function. The report finished by declaring such a commitment was necessary in order to ensure adequate resources for the commercialisation role.

Ireland is currently going through the difficulties that the Australian biotechnology went through about five years ago, as it also was not in the commercial aspect of biotechnology from the start and was a relatively late arrival to the global stage. Australian research institutes and universities have also yielded innovations that could have been furthered with proper development and funding but could not because of lack of growth capital and inexperienced management in this sector. To an extent Ireland is currently facing similar problems. The Australian Biotechnology authorities developed three strategies to try and overcome these obstacles to further development.

The strategies were:\[11\]:
- (1) Heavy reliance on public capital to develop a revenue stream leveraging aligned products and services.
- (2) Improve access to foreign capital through mergers with foreign companies.
- (3) A third strategy used by Australian companies was to partner early with larger foreign-based companies to gain access to sophisticated and expensive development capabilities.

From these strategies conceived five years ago, greater government incentives had been made available, funds have been raised from overseas and some Australian companies have set up in the US and recruited the necessary and experienced management. Also initiatives have been put in place to promote the national visibility of the sector as well as a new an improved national BioAus website.

\[11\] Timothy F Herpin et al, Australian Biotech companies: Navigating the maze, 2005
Conclusions

This paper has provided an insight into the resources as well as the funding methods used by Irish biotechnology companies at present. As the paper shows, there is a fissure between the biotechnology funding available and the demeanour in which companies are seeking out and searching for the funding, which is vital to their continued existence if they want to strive forward into the global market place.

As Ireland is a small open economy, it will need to develop a critical mass if it is to create a successful biotechnology sector on the island. However the policy makers and state agencies are trying to narrow the gap between policy objectives and implementation with newly set up support agencies and funds managers. With all these stakeholders put in place, the indigenous industry is still between seed and early growth stages and major issues are surfacing regarding collaboration, commercialisation and access to funding with administrative and industry problems slowing down the Irish biotechnology industries progression into a state of sustainability and expansion.

Irish biotechnology can learn from the experiences of foreign sectors that are at a more advanced level and draw on them to make sure that Irish industry does not experience the same barriers to growth and development.

Funding opportunities are significant for both investors and companies in search of investment. Although with the nature of the industry and the medium-term cash flow problems companies endure, the venture capital state management consortium has the necessary funds and skills to help indigenous companies overcome such apparent and critical shortcomings experienced in the biotechnology industry.
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ABSTRACT

Research on the management of innovation is considered to be one of the main drivers of economic growth and prosperity in the knowledge economy and in South Africa. Understanding and managing innovation processes and structures in general and particularly in South Africa have the potential for huge benefits for actors, local clusters, and the national system of innovation. The purpose of the present research is to develop a research focus in the management of innovation at an institution of higher education in South Africa. Research in this area should promote knowledge in the fields of technopreneurship, technology management and transfer as well as intellectual property.

Key words: Innovation, research niche, information packages

Introduction

The 2004–2008 Research and Development Strategy of the Tshwane University of Technology, South Africa contains two significant statements namely that the University:

- Will focus on research, technology, demonstration and innovation; and
- Will promote and develop a “limited number of Research and Innovation Focus Areas” around themes that address some of the priorities and needs of South and Southern Africa (Strategy for the Integration of Research & Development and Technological Innovation (TI) and Technology Transfer (TT), 2005).
The above strategy implies that at Tshwane University of Technology focus and niche areas will become the primary vehicle for the full spectrum of activities in the research and innovation chain. In this regard, the focus of entrepreneurship and innovation education and research at institutions of higher education ipso facto implies a wish to enhance the quality of graduate and post-graduate business venturing prospects and business know-how in the normally pre-entrepreneurial stage. This takes place within a sense-making framework that underpins a research and education agenda for graduate entrepreneurship in a country in which a need exist to, on the one hand, develop effective entrepreneurial, management and creativity skills, and on the other hand to create a desire in graduandi to start entrepreneurship as a career (Hannon, 2005:2). It should further be of such a nature that the content guides the competitive landscape in which the prospective entrepreneur will function and not lag behind and thereby may loose its relevance.

**Purpose**

This paper focuses on the development process of a niche research area in the field of management of innovation at Tshwane University of Technology (TUT), South Africa. Through the research process followed, the research domain was defined as participation in creating data, new product ideas and knowledge through the research and the development of models to support better understanding of the business innovation processes, and to plan and implement interventions to the benefit of the actors in the innovation system. Of particular importance in this research and innovation area is to create understanding and implementation skills on systematic innovations and incubator designs and the management thereof through empirical and participatory action research methods. Initially the focus will be on clarifying the role of the University of Technology in the National Strategic Innovation Framework, followed by a shift in the research focus domain towards:

- Technological change and the effects thereof on the business environment.
- Characteristics of innovative organisations in South Africa.
- Patterns of technological change. This area of research will typically investigate questions like how does technology evolve, what are the dominant design forms and what are the dynamics of innovation.
- Research on the management of technological transitions which include aspects like disruptive technologies, and the reconfiguration of existing technologies as well as the impact thereof on business success.
- The effects of standards and network externalities on technological and business competition.
- Research on the management of intellectual property.
- Futuristic studies assisting businesses to scan the technological environment for emerging technologies.

**Scope**

The scope of the paper is to propose a research framework for the management of innovation suitable for a University of Technology in a developing country, enabling it to become both a producer and consumer of innovative entrepreneurial information packages and protocols. The literature review illuminates the evolutionary paradigm changes over time and is followed by the research design and methodology used to derive at a niche research area in the management of innovation. The major findings of the research are discussed, followed by a logical conclusion.
Literature Review

According to Frederick and McIlroy (1999), in the new economy, technology and knowledge production on which it is based, have become an intrinsic part of the economy as well as the third factor of production in leading economies. As a result, it may be envisaged that education and research in institutions of higher education will need to support the complete technology development process, which also include the process of innovation. In this regard, it may be more appropriate to develop education and research policies that addresses the complete technology-innovation chain than merely the research-development chain, as the research-innovation chain involves taking ideas, turning them into technologies and taking these technologies, through research and development, out of the laboratory and proving them in real-world situations.

The above requires the demonstration of entrepreneurship by universities. As far back as 1983, Miller (1983) suggested that the level of entrepreneurship present in an organisation, and thus a university, could be treated as the extend of taking risk, introducing innovation and developing pro-activity. As such, innovation is seen as an important determinant of entrepreneurship or at least of the entrepreneurial orientation of the organisation (Covin & Slevin, 1989; Lumpkin & Dess, 1996; Zahra & Covin, 1995).

However, the innovation paradigm, as a component of entrepreneurship, changed and evolved over time. Park and Kim (2006) identified four principle generations of Research and Development (R&D) systems as it relates to time:

1) The period 1900 – 1960: During this period little attention was given to the economic management of R&D. However, a lot of freedom was given to researchers in science-based laboratories to determine their own research focus and methodologies.
2) The period 1970’s – 1980’s: This period is characterized by a scientific and microscopic management approach to R&D.
3) The period 1990 – 2000: This period is delineated by a strategic and holistic approach to R&D.
4) The period 2000 - : In the current period a new R&D system is starting to emerge in which the primary objective is to identify the latent needs of prospective customers and to secure the technical feasibility and marketability in the very early stages of innovation. Thus, the current R&D system magnifies the role of information technology and emphasizes the platform and architecture of the whole system. In this regard, knowledge management becomes simultaneously the driving force and essential building block for the R&D system. It is therefore not surprising to find that in this system’s approach, the customer is not seen as the crucial asset, but rather the knowledge. In this view the R&D process is seen as a knowledge management process that transforms information on technological advancements and market demands into knowledge which can be used for developing new product concepts and process designs.

Thus, innovation according to Park and Kim (2006) has moved from unfocussed innovation approaches to a scientific reductionistic approach to a strategic and holistic approach to the ability to identify the latent needs of customers and the technological feasibility of an innovation. The latter requires a strong platform founded on information technology. This perspective capsulate and expand on the views of Sundbo (1995), whom identified a technology-driven innovation paradigm focusing on the technician as innovation agent, the
technological development paradigm which is an important determinant for innovation as well as the strategic paradigm which encompasses a market-and organization oriented perspective on innovation.

Assumptions

This paper is based on the following assumptions:

- The management of innovation at the university is enhanced if it possesses up-to-date knowledge capabilities, resources and routines that will support the identification of latent consumer needs and technological developments;
- Management of innovation will improve if staff and student’s entrepreneurial and management capabilities are maintained and grown in a focused and systemized manner; and
- The capacity to absorb research data will increase if the data relates to applicable knowledge in syllabi and to key entrepreneurial challenges in the local and regional environment.

Research Methodology

The research methodology followed was conducted in two phases and is described below.

Phase 1: Development of a Research Framework for Entrepreneurship and Innovation

The development of a research framework for entrepreneurship and innovation has been derived from a focus area approach. This approach was grounded in the belief that a focus area could become a centre of research excellence with a strong applied character. Through the utilization of expertise and the experience of various stakeholders ranging from government to science councils and industry, priorities and needs were identified that could form the base for the development of Research and Innovation (R&I) activities at the institution. This approach was important in the belief that R&I need to be more focussed on the applied and strategic areas, including product development and process-related work. In all of this, the transfer of expertise, the transfer and diffusion of technology and the successful demonstration and implementation of results forms an integral part of the focus area approach followed. The focus area approach thus provides the framework that guides the research activities of the group, and the individual. Within a specific focus area disciplinary, interdisciplinary and trans-disciplinary research is encouraged.

With regard to the entrepreneurship and innovation focus area development, an interpretive epistemology research design approach was followed in the belief that entrepreneurship and innovation is a socially constructed concept and seeks its articulation through human sense making on the part of academic researchers. The first objective was to determine and interpret the intent of the National Research Foundation (NRF) with regard to reforms and expectations in Science and Technology research and the Humanities. Researchers from all Universities in South Africa contributed to this debate by presenting papers at provincial conferences and afterwards debating the issues for a month through the Internet under the guidance of theme leaders. Based upon these inputs a broad National Framework for Research and Innovation in South Africa was developed.
The second objective was to encourage different Academic Faculties to develop specific research focus area in which each could develop a specific strengths and expertise as well as the correct mixture of research type. Therefore, the second objective was to obtain clarification on what entrepreneurial and innovation research was already conducted at the university in the realisation that horizontal links or interactions between research institutions in the various faculties hardly existed. The results obtained indicated great variety and lack in research focus, research methodology and were sporadic in nature. It furthermore revealed that research conducted was aimed more at solving specific problems with limited financial resources and that research efforts were closely linked to the particular interests of a specific researcher. The need was thus established to create a research structure and focus that could accommodate the research interests and needs of the particular researchers, support the national research needs of the country, have long term scientific value and that could attract more research and innovation funds from the NRF, industry and other donor organizations nationally and internationally.

A workshop was organised in which the current status of research and innovation in entrepreneurship were explained to researchers. Under the leadership of a workshop facilitator, core ideas were developed that were aimed at guiding the new appointed research focus- and niche-area leaders to develop an unique, comprehensive but focused entrepreneurial and innovation research and development initiative for the University.

Based upon the guiding principles provided, a five-round Delphi technique was used in which 32 academics from three academic faculties representing 11 departments and six centres of excellence, participated. Four advisors from the Research and Development Office provided guidance and advice regarding the alignment of ideas with that of the National Research Foundation’s priorities and specifications. Data was consolidated and interpreted by the research focus area leader. Representativeness of responses was sought based upon the plausibility and the similarity of the logical reasoning of participants. Data was then classified into three principle research niche areas: business clustering, business development and management of innovation. Basic content for each research niche area was created and refined under the leadership of each niche area leader. A research focus area document was compiled, submitted for approval, firstly at Faculty Research Committee (FRC) level and then for final approval by the Central Research Committee (CRC) of the University.

**Phase 2: Development of the Research Niche Area on the Management of Innovation**

The purpose of the second phase was to clarify the content of each niche area to a critical mass of people interested to do research under a central theme. Whilst the titles of each niche area were decided upon, a central theme that could act as guiding principle was required in order to create knowledge excellence in each niche area. This was done in the realization that research excellence would largely depend on the interrelatedness of the research, quality of research conducted, alignment of research topics, quality of researchers and support that could be mobilized for the research niche area.

The process started with a briefing in which the aim and objectives of focused area research was again explained to the 22 participants from various departments attending the workshop. This was followed by an academic input in which the focus area: Entrepreneurship and Innovation were explained and elaborated on. The UNESCO Chair in Technological Entrepreneurship then provided a perspective on the Management of Innovation. These three
inputs served as point of departure for the development of the niche area on the management of innovation. The 22 participants were then divided into three groups with the task of:

- Formulating a central theme and research domain for the niche area;
- Defining nominal definitions for key concepts identified;
- Offering a motivation and a rationale for the central theme;
- Indicating the unique features of the niche area for the university; and
- Specifying the specific aims and objectives of the niche area.

This phase was completed after utilization of a three-round Delphi technique in which feedback was provided to the niche area leader responsible for consolidating the information and ensuring final approval from firstly the Central Research and Innovation Committee of Tshwane University of Technology and secondly from the National Research Foundation (NRF) of South Africa.

Findings

**Defining the Niche Area**

The principle aim of this research niche area is to develop specialised knowledge management systems and information packages for the Management of Innovation in terms of specific knowledge management activities as well as knowledge management functions that needs to be performed in order to support and facilitate entrepreneurship and innovation in the SADC business context.

**Nominal Definitions of Key Concepts**

*Knowledge Management Activities* relates to all activities needed to facilitate the ability to transform information based upon technological advancements and market demands into knowledge which can be used for developing new product concepts and process designs.

*Knowledge Management Functions* relates to those functions supporting the execution of knowledge management activities by providing specific and practical technologies or tools to the researchers.

The *SADC* refers to the 14 member states of the Southern African Developing Community and include Angola, Botswana, Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

**Rationale and Motivation**

The Management of Innovation niche area intends to transfer entrepreneurship and innovation research from the laboratory or research phase to the intellectual property right phase and through to the marketplace in collaboration and in partnership with industry and other relevant stakeholders. The intention of the research phase is to locate the principle responsibility of the research up to the prototype phase within the higher education environment, after which the commercialisation of the prototypes and protocols will gradually shift to industry. Following this approach scientists and researchers and Tshwane University of Technology, as creators of Intellectual Property information prototypes and
protocols, will gain direct financial benefit from the successful transfer of their inventions to the marketplace.

**Unique and Outstanding Features of the Niche Area**

This research niche area will generate aggregate data and information packages and prototypes that could be used by all potential beneficiaries operating in the field of innovation. The research results will also stimulate the transfer of knowledge and cross-pollination of regional development through the transfer of information and knowledge to individual business domains. The innovation information packages and prototypes provided, will not duplicate information of other institutions of higher education, but will rather complement the current body of knowledge and create new opportunities on which to build new innovations. Research in this niche area takes as departure point that information and knowledge is the principle driving force that underpins innovation, stimulates the development of new technologies, and creates the ability to identify latent consumer needs and creates the possibility to determine ex ante the technical feasibility of an innovation.

The Entrepreneurship and Innovation Barometer glossy publication envisaged will provide information on an annual basis whether Southern Africa is improving or deteriorating regarding entrepreneurship and innovation.

**Goals**

The specific goals to pursue include:

- The development and publication of a glossy journal that is based upon similar lines as the European Innovation Scoreboard will serve as an innovation barometer for the SADC. The barometer will be designed based upon the development of an index composed of two main groups namely Innovation Input and Innovation Output. Innovation drivers, knowledge creation and innovation entrepreneurship indicator sets will capture the development of Innovation Input indicators. The Innovation Output indicators will be captured using intellectual property indicator sets;
- The development of Innovation Business Case Studies that culminated in high-growth business start-ups in the SADC;
- To capacitate and support the innovation of products and processes by creating and integrating utility information packages and prototypes ready for registration as intellectual property for commercialisation purposes and for application and usage by entrepreneurs, innovators and institutions of higher education in the SADC;
- Exploration and description of a common knowledge framework for innovation creation taking into account the specificity and particularities of the SADC region in relation to other regions of the world;
- Investigating the process of managing the sustainable application and utilisation of novice technology in an optimal manner; and
- Making innovations in the areas of business processes, manufacturing, materials composition, information software, written work, design, imaging and knowledge systems useful in practice through the development of skills upliftments and entrepreneurial programmes and contextualising the unique innovation driving forces and constraints in the SADC regional framework.
Specific Research Objectives include:

- Provision of community lay knowledge and scientific knowledge information packages and prototypes that will facilitate the development and commercialisation of truly Southern African products and services;
- The development of comprehensive entrepreneurship and innovation indicators that will facilitate the development of entrepreneurial and innovation strategies for Southern Africa;
- The enhancement of the international competitiveness of Southern Africa through design and manufacturing, protection of intellectual property rights and the establishment of an innovative culture in the region;
- Emphasis will be given to the understanding of innovative technology and the applications thereof;
- Technological change and the effects thereof on the business environment;
- Identifying characteristics of innovative organisations in Southern Africa;
- Describing patterns of technological change. This area of research will typically investigate questions like how does technology evolve, what are the dominant design forms and what are the dynamics of innovation;
- Research on the management of technological transitions which include aspects like disruptive technologies, and the reconfiguration of existing technologies as well as the impact thereof on business success;
- The effects of standards and network externalities on technological and business competition;
- Research on the management of intellectual property; and
- Futuristic studies assisting businesses to scan the technological environment for emerging technologies.

Scope and Future Direction of Research Niche Area

To ensure the sustainability, growth and relevance of this niche area within the SADC region the following initiatives will be pursued:

- Development of local and international strategic partnerships and alliances through amongst others UNESCO, the African Union (AU) and the European Union (EU).
- Research results will be integrated into the local curricula of Tshwane University of Technology, enabling the application of knowledge in a specific region without loosing global relevance.
- Quick-building of specific innovative knowledge through the pooling of an inter-disciplinary yet focussed research approach as well as through strong coalition forming between indigenous knowledge systems and scientific knowledge systems.
- Synergy forming in thinking approaches amongst different stakeholders within the SADC region.
- The development of innovation information packages and prototypes tailored to the SADC context to address the needs of the SADC and suitable to the resource capabilities of the region.

Strategy

In order to take the research niche area forward it was decided that strategic partnerships and
alliances should be formed with amongst others UNESCO, AU and EU. A multilateral UNESCO application (Tshwane University of Technology of South Africa, Saint Thomas University of Mozambique and the University of Trento, Italy) has already been submitted to support local development in Southern Africa. The Management of Innovation niche area would benefit from this application. An Erasmus Mundus grant was also secured for the period 2006 – 2009 to research innovative processes whereby SMME’s could be better organised to support growth and development. A SANPAD application was also submitted to investigate innovative ways for the greening of grape product chains to the EU.

To ensure the sustainability of the niche area a goal was set that the niche area should be supported by at least 15 fulltime post-graduate students from different academic disciplines and the in-sourcing of experts on a part-time basis to provide a strong research source for this focussed research approach. Course supervisors from the different involved faculties were therefore approached to ensure that students are sensitised towards the management of innovation in curricula and that possible research topics in this area should be proposed to students in order to activate this particular research domain. This process would be facilitated by the Centre for Entrepreneurship which would act as a virtual academic department across faculties.

In order to ensure participation, two workshops will be organised with the emphasis on defining and clarifying the content of the niche area: Management of Innovation to participating members. Further, the Centre for Entrepreneurship will host the fourth International Conference on Entrepreneurship and Innovation during October 2006. At this event participants will get the opportunity to present their research results. A post-graduate session will also be organised during this event.

**Mentoring, Supervision and Training**

In order to ensure the scientific integrity of the research, the Faculty of Management Sciences will utilise and in-source expertise from EU universities to provide insights with regard to general research trends and methodologies in the field of the management of innovation. In 2006 Prof. B. Dallago from the University of Trento will specifically assist to develop a three year operational research agenda in this field in order to ensure that comparable and aligned research is conducted. Through the UNESCO Chair in Technological Entrepreneurship, a coordinating research network for SADC researchers will be established to finalise, coordinate and supervise research conducted in the field on Management of Innovation.

**Constraints Imposed on Researchers**

To foster specialized expertise in this field, the following constraints have been imposed on TUT researchers operating in this field:

- The research outputs should guide the development of information packages, protocols or prototypes that could be used by entrepreneurs, educators and other stakeholders for educational purposes and the development of incubators for commercialization purposes of the innovative idea(s);
- The departure point of the Management of Innovation should be based upon a venture-oriented approach by stimulating researchers’ action rationality and innovative ideas through business generation models and activities;
• The research should be embedded in the entrepreneurship educational and research philosophy, ideology and value system of TUT and in which institutional infrastructure will be created to enhance the competitive positioning in the latent entrepreneurial student market; and
• The research in this niche area may occur on three levels. First-level research will refer to “up-stream” research which is primarily curiosity driven, either experimental or theoretical in approach, aiming at advancing the frontiers of Management of Innovation knowledge. The second level known as “mid-stream” research will refer to project driven research linked to a development purpose, whilst third-level research, known as “down-stream” research will focus on research projects committed to further commercialisation processes.

Conclusion

It is envisaged that the approval of the Management of Innovation niche area will lead to an increase in project-based research and innovation (R&I) and a shift in the relationship between researchers and funders, which will require corporate support of the university as staff will require more guidance on available opportunities and how to apply for them, to best effect and adhere to complex contractual arrangements.

The successful implementation of the research niche area on the Management of Innovation is dependent not only on support mechanisms provided by the University of Technology, but also the motivation of staff and students to actively engage in and focus their research efforts on the specified niche area, as well as the infrastructure created to develop information packages and protocols.

References

ADOPTION OF ALTERNATIVE TRANSPORT TECHNOLOGIES IN THE CONSTRUCTION INDUSTRY

Thijs Habets, Hans Voordijk and Peter van der Sijde
Twente University, P.O. Box 217, 7500 AE Enschede, The Netherlands

ABSTRACT
This research examines how the construction industry adopts alternative transport technologies. This paper presents the general characteristics of the adopter and what his perceptions are towards innovative transport technologies. The study focused on four rates of innovation, related to alternative transport technologies. The results show that 83% of the respondents choose innovation over no innovation; more than half of the respondents choose an innovation that can be characterized as “architectural”. Further, the perceived benefits of the innovation characteristics for an incremental innovation are higher then the perceived benefits for an architectural or radical innovation. Finally, from the ventures that chose to innovate, smaller companies prefer an architectural - more challenging - innovation rather then an incremental innovation.

Keywords: adoption processes, transport technologies, construction industry

INTRODUCTION
Transportation of materials in the construction industry is surrounded by a number of logistical problems, such as bad transport planning, long waiting times at construction sites, and strict environmental regulations and time schedules (Agapiou et al., 1998; Cox and Ireland, 2002; Risku and Kärkkäinen, in press; Voordijk, 2000). There are, however, several technologies available to solve these problems. Examples of these technologies are the application of ICT and simulation tools when planning transport (Ort and Schoormans, 2004; Power and Simon, 2004; Russell et al., 2004) and the implementation of alternative transport technologies besides the dominant mode of road transport when transporting construction materials.

In general, benefits from new technologies depend on the extent to which these technologies are adopted and utilized (Mitropoulos and Tatum, 1999). The construction industry has a reputation of being slow in adopting and utilizing new technologies. Our understanding of how construction organizations make decisions to adopt new technologies is very limited. Several important questions remain. How does the need for technological change emerge? How do managers select new technologies? Is innovation driven by company goals, internal and external organizational actors, or does it happen only when environmental conditions allow it?

The purpose of this study is to provide insights in the in the adoption processes of a particular set of technologies in the construction industry and the factors affecting these processes. Research focuses on the adoption of new transport technologies in the construction industry.

The conceptual framework is based on literature on technology-adoption and entrepreneurship. Empirical research focuses on a particular part of the construction industry; the road construction industry. The outline of the paper is as follows. First, our theoretical framework is introduced. Secondly, we characterise processes in the road construction industry. Then, the research design and the first empirical results are presented. The paper ends with discussion and conclusions.
THEORETICAL FRAMEWORK
Entrepreneurship is a process, directed by the entrepreneur (individual or organization), in which opportunities are recognized, prepared and exploited. The aim of this process is creating value (Van der Veen and Wakkee, 2004). The first stage of the process, opportunity recognition, is the stage where the entrepreneur identifies initial ideas. The second stage, opportunity preparation, is where the entrepreneur develops the initial ideas into feasible concepts. The last stage, opportunity exploitation, is where the opportunity is realized and brought to exploitation. This process takes place in a social system (Groen, 2005; Parsons, 1977). The process and the social system theory together make up the Entrepreneurship in Networks (EiN) model. This model conceptualizes that within the entrepreneurial process four kinds of capital are accumulated to create value:

- Economic capital; can be seen as the financial resources, mainly money, a venture has available.
- Strategic capital; can be seen as the way a venture positions itself in the market, and attains a certain power.
- Cultural capital; can be seen as the knowledge, know-how, experience, and values a venture puts into practice.
- Social capital; the relations an entrepreneur and his venture has with his environment, how he acts in his network.

The central hypothesis of the EiN model (see Figure 1) is that entrepreneurs for each of these four dimensions will need sufficient capital to create sustainable enterprises within networks (Groen, 2005). Schumpeter (1934) associates entrepreneurship with innovative and change oriented behavior, whereas the latter include also task-related motivation, expertise, and expectation of gain for self. Entrepreneurs need to create value, for this the need new innovative ways to achieve this. In general, there are three types of innovation.

- The first one is incremental or continuous innovation, this concerns step by step minor improvements of products processes or services. It can be seen as some kind of an evolution theory, in which the species “upgrades” itself slowly to the environment.
- The second type of innovation is the discontinuous or radical innovation; this type of innovation permits entire industries and markets to emerge, transform, or disappear providing a firm a significant advantage (DeTienne and Koberg, 2002). Consequently,
this type of innovation usually triggers the Schumpeterian process of creative destruction (1934).

- The last, the architectural innovation applies technological or process advances to fundamentally change some component or elements of the business (O’Reilly and Tushman, 2004). This innovation is, compared to the other two types, an ‘in between’ innovation.

The innovation in general is defined as an idea, practice, or object that is perceived as new by an individual or unit of adoption. Adoption is a decision to make full use of an innovation as the best course of action available (Rogers, 1983).

A mainstream general theory on adoption is the “perceived innovation characteristic theory” (Rogers, 1983). A more specific model, the Technology Acceptance Model (TAM), is developed for the adoption of IT (Davis et al., 1992). The main difference is the focus of the two models: Rogers emphasizes the characteristics of the innovation, so the expectations an adopter has about the innovation. In the TAM model, the emphasis is put on the adopter characteristics, so to what extent typical features of the adopter influence the innovation adoption.

Rogers (1983) underpins that there are different success rates of adoption. To explain these different rates of adoption Rogers recognizes five criteria:

- Relative advantage; is the degree to which an innovation is perceived better than the idea it supersedes.
- Compatibility; is the degree to which an innovation is perceived as being consistent with existing values, past experience, and needs of potential adopters.
- Complexity is the degree to which an innovation is perceived as difficult to understand and use.
- Trialability; is the degree to which an innovation may be experimented with on a limited base.
- Observability; is the degree to which the results of an innovation are visible to others.

In general, innovations that are perceived by receivers as having a greater relative advantage, compatibility, trialability, observability and less complexity will be adopted more rapidly then other innovations (Rogers, 1983). Tornatzky and Klein (1982) confirm this and state that the attributes of the innovation at hand as perceived by the adopter have proven to be significantly instrumental in predicting adoption. Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983). The diffusion process is driven by individual perceptions and knowledge of people acting in a network. So the innovation adoption is also very much dependent on the adopter features and in which coherence the adopter interacts with others. The perceived innovation characteristics are predictors in terms of the innovation adoption itself but do not explain why the adopter has a certain attitude to this innovation. Tornatzky and Klein (1982) state that real objective attributes of an innovation do not exist and that the adopter will always chose an innovation which matches to their own system of values (Tornatzky and Klein, 1982).

The TAM is much more focused on adopter characteristics for predicting the innovation adoption which is influenced by two important elements: one is the perceived usefulness and the other is the perceived ease of use. Davis et al. (1989) define perceived usefulness as “the degree to which a person believes that using a particular system would enhance his or her job
performance’. Perceived ease of use refers to ‘the degree to which a person believes that using a particular system would be free of effort’. Hee-dong Yang and Youngjin Yoo (2002) state that the validity and reliability of these two constructs have been well supported by various studies.

THE ROAD CONSTRUCTION INDUSTRY
The objective of this study is to provide insights in the in the adoption processes of alternative transport technologies in the road construction industry and the factors affecting these processes. In general, road construction projects are executed all over the country on changing locations. The major input for road construction projects in terms of bulk materials is asphalt. Asphalt is produced at asphalt installations and transported by trucks to the location of the construction projects. Major problems for this time critical product are traffic jams and long waiting times at construction sites when delivering asphalt.

In road construction, the site manager has the most important position in organizing the project. He is responsible for the planning and safety and health issues new forms of procurement as turnkey and design and construct have resulted in an increase of the tasks and responsibilities of the site manager. For this manager, progress of work and prevention of disturbances has the highest priority. Slack in the use of equipment and asphalt is of minor importance. Acquisition of new projects has also become part of his activities. When a road is constructed, maintenance and repair provides work for a long period afterwards. Relations with existing clients are of utmost importance for getting work in the future; future work is often based on projects in the past.

Equipment is a critical resource in the execution of road construction projects. The equipment fleet represents the largest long-term investments in many road construction firms. Consequently, equipment management decisions have significant impacts on the economic viability of construction firms. Asphalt equipment such as asphalt distributor, asphalt spreaders, and paving machines used to spread and compact asphalt, demand high investments. Small equipment is often used before roads are paved. Examples are different sorts of ram compactors. In this study, the focus is on the adoption of alternative transport technologies in the road construction industry. The concepts will not (now) be elaborated, but are related to the extent of “radicalness” of the innovation.

HYPOTHESES AND RESEARCH MODEL
Accordingly, several studies have proven the significance of both the innovation characteristics and the adopter characteristics on the innovation adoption process. Van der Veen (2004), who combined the two models, remarked that perceptions are formed in the context of the firm.

In this paper adoption theory is incorporated into the entrepreneurial process, especially in the first stage (opportunity recognition) and partly the second stage (opportunity preparation). In the first stage a conceptual choice is made which needs further preparation to develop a tangible innovation. However the focus of this paper is on the “technology adoption” (see Figure 2). Based on the literature discussed the following three hypotheses are formulated:

- **H1**: The greater the perceived benefits of an innovation for an organization, the more likely the organization will adopt that particular innovation.
- **H2**: The higher the joint value of each of the four capitals, the more likely an organization will adopt a more discontinuous innovation.
- **H3**: The perceived innovation characteristics are formed in the adopter characteristics.
RESEARCH DESIGN
After analyzing experiences (collected by desk research) with alternative transport technologies, data was collected by a survey under managers of firms involved in the chain of production, transport and use of asphalt. The topics of the survey focused on factors affecting adoption processes of alternative transport technologies, such as objectives of the firms and the company’s external environment and internal characteristics. Data analysis contained a prioritization regarding adoption processes of alternative transport technologies of the firms analyzed.

The operationalization of research variables can be acquired from Table 1. Most of the items are adapted from Van der Veen (2004) (in Table 1 “VdV”), Rogers (1983) (in Table 1 “Rog”) and a meta analysis of Damanpour (1991) (in Table 1 “Dam”). Several items were self developed (in Table 1 “Self-d”). Items were measured on seven point Likert scales, percentages and multiple choice questions. The population included all asphalt producing and/or utilizing organizations. For the Netherlands 36 companies are found who are about 95% of the total population. Perceived observability is a left out variable of the innovation characteristics in questionnaire because of its estimated insignificance in relation with road construction business.

The concepts are related and arranged to four rates of innovation
- no-innovation
- incremental -minor- innovation
- architectural -in between- innovation and
- radical –major- innovation.
### Table 1 - Operationalization of the research variables

<table>
<thead>
<tr>
<th>Adopter Characteristics</th>
<th>Variable Tested on</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Capital; Financial position</td>
<td>Innovation budget</td>
<td>Turnover/ fte&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Strategic Capital; Strategic posture</td>
<td>Entrepreneurial orientation</td>
<td>Being first with new actions and innovations&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amount of implemented innovations&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not afraid of taking risks&lt;sup&gt;+&lt;/sup&gt; (consequently gain higher returns)</td>
</tr>
<tr>
<td></td>
<td>Customer and competitor orientation</td>
<td>Customer focused&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reaction on competitor actions&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collaboration / partnerships&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cultural capital; Knowledge and experience</td>
<td>Level of formal knowledge &amp; road construction experience</td>
<td>Educational level of organization&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Educational level management team&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fte on R&amp;D&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Social Capital; Network contacts</td>
<td>Activated information network</td>
<td>Searching for solutions outside the company&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Searching for opportunities&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visiting seminars and meetings&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation characteristics</th>
<th>Tested on</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived relative advantage</td>
<td>Concept improves the quality&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Rog</td>
</tr>
<tr>
<td></td>
<td>Concept improves the efficiency&lt;sup&gt;+&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concept improves the effectiveness&lt;sup&gt;+&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concept improves the reliability&lt;sup&gt;+&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Perceived compatibility</td>
<td>Concept fits within image/mission&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Rog</td>
</tr>
<tr>
<td></td>
<td>Concepts becomes obligatory forced by external environment&lt;sup&gt;+&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Perceived complexity</td>
<td>Concepts can be implemented easily within own organization&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Rog</td>
</tr>
<tr>
<td></td>
<td>Concept can be implemented easily within collaborating organizations&lt;sup&gt;+&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Perceived trialability</td>
<td>Concept can be experimented with&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Rog</td>
</tr>
</tbody>
</table>

**Technology Adoption**

<table>
<thead>
<tr>
<th>Innovation type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 no innovation</td>
<td>Self-d</td>
</tr>
<tr>
<td>1 incremental innovation</td>
<td>Self-d</td>
</tr>
<tr>
<td>2 architectural innovation</td>
<td>Self-d</td>
</tr>
<tr>
<td>3 radical innovation</td>
<td>Self-d</td>
</tr>
</tbody>
</table>

*Rog is source Rogers (1983), VdV is Van der Veen (2004)*. Self-d items which are self developed. “<sup>+</sup>” is positively associated to more prestigious adoption, “<sup>+</sup>” is negatively associated to more discontinuous adoption.
RESULTS
The results show that 83% of the respondents choose innovation over no innovation; more than half of the respondents choose an innovation that can be characterized as “architectural” (see Table 2). No respondents made a choice for an architectural or radical innovation.

Table 2 - Choice of innovation types

<table>
<thead>
<tr>
<th>Innovation type</th>
<th>Choice of respondents</th>
<th># of respondents</th>
<th>Average size of respondent’s companies (in fte)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no innovation</td>
<td>17%</td>
<td>n=2</td>
<td>153</td>
</tr>
<tr>
<td>incremental innovation</td>
<td>25%</td>
<td>n=3</td>
<td>317</td>
</tr>
<tr>
<td>architectural innovation</td>
<td>58%</td>
<td>n=7</td>
<td>190</td>
</tr>
<tr>
<td>radical innovation</td>
<td>0%</td>
<td>n=0</td>
<td></td>
</tr>
</tbody>
</table>

Sample size n(12) = 32% of total population

Further, as Table 3 shows, the perceived benefits of the innovation characteristics for an incremental innovation are higher then the perceived benefits for an architectural or radical innovation. The perceived benefits are higher for those who made a choice for a particular innovation then those who chose another. This is in support of our first hypothesis.

Table 3 - Innovation characteristics projected on innovation types

<table>
<thead>
<tr>
<th></th>
<th>Perceived relative advantage</th>
<th>Perceived compatibility</th>
<th>Perceived complexity</th>
<th>Perceived trialability</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>C*</td>
<td>K</td>
<td>C*</td>
<td>K</td>
</tr>
<tr>
<td>incremental innovation</td>
<td>40%</td>
<td>80%</td>
<td>24%</td>
<td>62%</td>
<td>54%</td>
</tr>
<tr>
<td>architectural innovation</td>
<td>33%</td>
<td>57%</td>
<td>28%</td>
<td>35%</td>
<td>51%</td>
</tr>
<tr>
<td>radical innovation</td>
<td>28%</td>
<td></td>
<td>25%</td>
<td></td>
<td>36%</td>
</tr>
</tbody>
</table>

K explains the average score of the innovation characteristic variable given by the respondents who do not chose this particular innovation type.
C* explains the average score of the innovation characteristic variable only given by the respondents who chose that particular innovation type.
∑* explains the total average score of the innovation characteristic variable given by all respondents for a particular innovation type.

The summed capitals do not discriminate between the architectural innovation and the “no innovation” choice (see Table 4). Companies that choose for incremental innovation have the largest amount of the four capitals in their organizations. Further, it appears that the larger the (average size) of the company the higher the total amount of the four capitals. The second hypothesis can only be confirmed with regard to the network capital. The (so far) collected data are not substantial enough to study the third hypothesis.
Table 4 - Adopter characteristics projected on innovation types

<table>
<thead>
<tr>
<th></th>
<th>Economic capital</th>
<th>Strategic capital</th>
<th>Cultural capital</th>
<th>Social capital</th>
<th>Summed capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>no innovation</td>
<td>0.11</td>
<td>0.64</td>
<td>0.57</td>
<td>0.60</td>
<td>1.92</td>
</tr>
<tr>
<td>incremental</td>
<td>0.45</td>
<td>0.68</td>
<td>0.83</td>
<td>0.68</td>
<td>2.64</td>
</tr>
<tr>
<td>innovation</td>
<td>0.29</td>
<td>0.62</td>
<td>0.46</td>
<td>0.59</td>
<td>1.91</td>
</tr>
</tbody>
</table>

*Each of the capitals is the average result per respondent group indicated on a scale from 0 to 1.*

PRELIMINARY CONCLUSION

Reflecting the results on the hypotheses, the data support in almost all cases hypothesis 1; the companies who choose for a certain innovation type, perceive in general a higher benefit value to this kind. The first results show that hypothesis 2 is not supported by the data; although the network capital is the only element that has a positive association to more radical technology adoption. There seems to be a positive relation between the size of a company (in fte) and the value of the four capitals. From the ventures that chose to innovate, smaller companies prefer an architectural -more challenging- innovation rather than an incremental innovation. A possible explanation for these outcomes could be that the perceived trialability needs a more elaborated network which offers ventures the resources they need to adopt an architectural innovation. At this moment additional data is collected to enable a more extensive evaluation.

REFERENCES


Technology-Market Matching in High Technology Small Firms

Hanna L. Hellman, Casper Boks
Design for Sustainability program, Delft University of Technology, Landbergstraat 15, 2628 CE Delft,
+31-152782120, h.l.hellman@io.tudelft.nl

Abstract
The commercialisation of a very new technology involves a gradual co-evolution between a developmental technology and emerging markets. The manner in which high technology firms match their technology to market applications has not been described in detail. The firms face critical market application decisions, whilst market demand is difficult to identify and customer desires are not explicitly known. Therefore, this research aims to gain insight into the determinants of market application decisions in high technology small firms. First, this paper reviews literature on strategic decisions and success factors of commercialising new technologies in entrepreneurial firms. Subsequently, the novel and current case of fuel cell technology is examined in an empirical case study of four fuel cell firms. The findings suggest that experience with product and market applications as well as a firm’s supply chain position are determinant for the selection of market applications. Further research may contribute to understanding of firm experience as a source of competitive advantage.

1. Introduction
In the early phases of technology commercialisation, high technology firms face uncertain decisions regarding the development and application of their technology. It is difficult to predict which markets will adopt their technology at which point in time. In the case of technologies that are new to the world, markets may not exist as yet. There is a market to apply a technology when a consumer is willing to pay for the technology. Consumer demand exists if there is a willingness to switch spending from the current solution to the new alternative (Howells 1997). Market applications for a technology will emerge as a firm’s technology matures. Historic cases have shown, Geels (2000) explains, that a technology is applied in various early adopter markets prior to mass-market acceptance. Scholars have described this process as the co-evolution between a technology and markets. As Martin argues “the process of new market formation involves much more than just getting a technology to work, it requires the formation of completely new social-technical relations” (2001: 63). The co-evolution between a technology and markets has been described at a socio-technical and industry level. However, at a firm level, the manner in which a maturing technology is matched to emerging markets has not been described in detail. How can a high technology firm, that targets the commercialisation of a technology as the key part of its development and marketing strategy, match its technology to markets?

The commercialisation of a new technology involves some kind of coupling or linking between a technology and markets (Balachandra et.al 2004, Coombs et.al.2001). A technology matches a market, in terms of consumer demand, if the technology performs a task that a consumer desires. Innovation and management literature has shown that success of a new product or technology is strongly related to this match (e.g. Cooper and Kleinschmidt 1986, Utterback 1994). High technology firms are challenged to identify
market applications and consumer demand as well as understand consumer desires whilst markets emerge and their technology matures. Matching a firm’s technology to markets involves uncertain decisions on market application, such as, the selection of markets, technology positioning and the timing of market entry. For the high technology firms in an emerging industry, these decisions can be determinant for firm survival and development. This research, therefore, aims to gain insight into the rationale behind their market application decisions.

This research examines the novel and current case Fuel Cell (FC) technology commercialisation. This clean energy conversion technology has the potential to replace combustion engines and batteries in a broad range of products. Over the past ten years numerous FC related firms have been established for the development of fuel cell components, systems and products. This study will examine a selection of these small and entrepreneurial firms. The firms work in an extreme environment of technical challenges as well as a scarcity of available resources. Commercialising their technology, FC firms face challenging market application decision. There are a multiple applications to choose from, whilst it is unclear which markets will accept the technology at which point in time. Additionally, there is high potential for mass market application, but widespread adoption is preceded by a long pre-commercial period of demonstration, experimentation and learning.

This paper will examine the interplay between high technology firms and their customers in matching a technology to markets. The following questions will be addressed: 1. How is a technology matched to markets at a firm level? 2. What variables influence the match between a firm’s technology and market applications? Primarily literature is reviewed to gain insight into the strategic decisions and success factors of technology commercialisation. Subsequently, the methodology and results of the empirical research on small FC firms is described. Finally, based on the theoretical and empirical findings, technology and market matching at firm level is discussed.

2. Literature review
The commercialisation of a technology by high technology small firms draws upon research in multidisciplinary fields. This paper will consider three fields of literature to gain insight into market application decisions and success factors. First, literature on commercialisation strategies, from both a technology and market perspective, will be addressed for an overview of the strategic decisions faced. Second, this paper examines small and entrepreneurial firms and will, therefore, describe literature on the characteristics and success factors of entrepreneurial firms. Finally, characteristic variables of a technological innovation will be described from innovation management literature.

2.1 Technology strategies
A broad scope of literature addresses different aspects of strategic decision making for technology commercialisation. Technology management scholars have described ‘technology strategies’ in high technology-based firms from the rationale that the management of technology is a determinant of firm survival and performance (e.g. Hamel
A firm’s technological strategy implies decisions on which R&D activities to conduct, how and at which point in time. The selection of R&D activities includes decisions on their scope of technology and the degree of R&D investment. A firm may choose to focus its R&D activities to specialise and deepen its proprietary competences, or a firm may choose to conduct a broad scope of R&D activities to secure flexibility and adaptability (Hung et al. 2003). A firm may choose to invest in particular R&D activities or not, depending on its perception of commercial value. Regarding timing, firm’s face a strategic choice whether to pursue a leadership role in the development and application of a technology or follow competitor firms in established trajectories. This aspect of entry timing has received extensive attention (e.g. Kalyanaram et al. 1995, Lieberman and Montgomery 1988). ‘First mover’ advantages of a leading firm are often emphasised, however, scholars have also described follower advantages. Lastly, a firm must decide to develop the technology through internal R&D, through alliances or outsourcing. Advantages and disadvantages of each strategy have been argued in literature. Implications of strategy decisions with regard to the selection of R&D activities can be described through the resource or competence based theory of the firm because the decisions are determinant for the development of a firm’s proprietary resources. Besides these issues of technology development, the commercialisation of a new technology involves strategic decisions on marketing and market development.

### 2.2 Marketing strategies

Research on marketing management has described high technology launch and marketing strategies (Shanklin and Ryans 1987, Easingwood and Beard 1989). The rationale behind these studies is that appropriate strategies must be adopted to accelerate rates of adoption to minimise the ‘burn-out’ risk of pioneers. Strategic decisions include positioning the technology or product in a market through the identification of specific customers and market opportunities. Literature on innovation-market dynamics and the diffusion of innovations show that different customer segments will adopt innovations at different times. Typically, ‘innovative adopters’ or ‘professional heavy users’ are early ‘niche’ markets for a new technology or product. Furthermore, Shanklin and Ryans (1987) explain how the strategic application of a new technology in the market place is characterised by a dominance of supply side marketing. Additionally, firms have to deal with the uncertainties customers have. Strategies to cooperate among competitors in an industry have been suggested to help educate customers and stimulate market demand. A third group of strategies are directed at the adoption behaviour of customers. First, the reduction of the risks that customer’s associate with adoption and second, winning market support. Scholars suggest that customers will be more likely to adopt a new technology if the customer can try-out the new technology (e.g. Frambach 1993, Easingwood and Beard 1989). Another approach, although rarely implemented, is for the supplier of a technology to absorb the risk of adoption. Finally, strategies are suggested to win market support by establishing a good reputation.

The above mentioned marketing strategies are, to a certain degree, applicable to both business to business and business to consumer sales, as well as the sales of a product to end-users or a sub-system to original equipment manufacturers (OEM). However, it can
be expected that the sales and supply chain characteristics influence the matching of a technology to markets.

2.3 **Entrepreneurial firms**
What characteristics of an entrepreneurial firm influence firm decisions and firm success? High technology entrepreneurial firms are challenged to grow in an extreme environment of, on the one hand, technological challenges and high investments and on the other hand, a scarcity of available resources and competences. Historical cases have shown that only a small percentage will survive (Olleros 1996). Several studies have identified factors related to the success of an entrepreneurial firm. Kakati (2003) provides an overview of factors covering six areas: entrepreneur quality, resource-based capability, competitive strategy, product characteristics, market characteristics and financial data. Researchers have stressed the role of the entrepreneur, in particular the individual’s motivations and qualities, in the success of an entrepreneurial firm. The founders play a critical role in gathering resources and developing strategies to push a product through market. Although the entrepreneur’s quality and the firm’s origin impact the capabilities and strategy of a firm, Kakati (2003) argues that the resource based- capabilities and competitive strategies of a firm are equally critical. Regarding capabilities, Oakey (2003) additionally recognises that a complex mix of both technical, market and managerial skills are necessary for the success of high tech firms. However, research has also shown that solely having the capability is not a guarantee of success. A commercial understanding through prior experience with customers and markets proves to be critical in the development of a new firm. This prior experience, with customers and applications, is repetitively emphasised as a prominent factor to successfully recognise and exploit market opportunities (Shane 2000, Ardichivili 2003). Nerkar and Roberts (2004) have termed a firm’s experience within markets as ‘product-market experience’. The relevance of prior experience poses a dilemma for entrepreneurial firms in an emerging industry: they have gained limited product-market experience, yet market applications have to be identified. Several FC firms, for example, are initiating applications and projects with limited experience of their technology in practice.

2.4 **Innovation success**
Innovation management and product development studies have examined numerous success factors for new product development. Here it is repetitively emphasised that a new product should address market needs and that a firm requires an in-depth understanding of customer requirements and demands. However, the difficulty of recognizing customers and their needs, in early phases of technology commercialisation is also recognised (Friar and Balachandra 1999). Certain management practices have shown to be effective for managing this uncertainty, namely, market experimentation or probe and learning (Lynn et.al. 1996). Cooper and Kleinschmidt (1986) have additionally shown that prototype testing with customers has a positive impact on the launch of a new product. Jolly (1997) explains that mobilizing interest for, proving the value of and demonstrating a new technology are critical activities in the process of technology commercialisation. The characteristics of an innovation itself are also known to influence the success of a new product. The novelty and complexity of a new technology are
negatively related to the success of a new technology because these characteristics generate uncertainty.

Concluding from the above literature review, the development and marketing of a firm’s technology involves several strategic decisions on the development of the technology and markets. Matching a technology to markets at firm level concerns the identification of customer demands and decisions on the selection and timing of market applications. The crux of uncertainty is the difficulty to understand and identify customer demand. Additionally high technology firms have to deal with customers’ unfamiliarity with their technology. Innovation and entrepreneurship studies show that the characteristics of both technology and firm are likely to influence a firm’s strategic decisions and subsequent performance. Based on the literature review above, it can be expected that entrepreneurial ambition, resources, capabilities and prior experience with market application, will influence a firm’s selection of market applications. Additionally, a match between a firm’s technology and customers will depend on how a firm manages the novelty and complexity of its technology.

3. Empirical research

3.1 Case study of fuel cell firms

Fuel cells are energy conversion devices that have the potential to replace batteries and combustion engines in a broad range of product applications. However, it is expected that it will be long before a breakthrough into true mass market sales is made. In the meantime FC firms are gradually applying their technology in various niche markets as well as demonstration projects. For FC firms, the challenge of matching FC technology to markets lies in the selection of markets, the identification of customer demand and the timing of applications. In which applications and projects will a FC firm invest its scarce time and financial resources? FC firms show heterogeneous strategies for market application. The firm’s match their technology to markets in differently. This research will examine these differences and attempt to explain the motives, drivers and rationale behind the heterogeneous market application decisions.

To understand how technology and market matching takes place within FC firms, this research requires an in-depth look at FC firms. A case study research strategy is utilised to examine a select number of fuel cell firms. As Yin (1994) explains, case study research is suitable to study real world situations and particularly suited to identify multiple factors that influence the phenomenon under study. The case study research is primarily conducted through open interviews with fuel cell firms. Besides, firm data is collected on the resources and activities of each firm, including patents, press releases and financial data.

3.2 Case selection and description

Four case firms have been selected based on a maximum difference of market application strategy. Two market application decisions are taken as dependent variables in order to examine the factors that have determined these decisions. These dependent variables are, the way market applications are selected, and the time horizon on which the first market
application is expected to become commercial. Figure 1 shows how both dependent variables were used to motivate the choice of four case study firms.

Regarding the selection of market applications, firms can choose to focus on a narrow and specific technology application trajectory or choose to compete on a broader field of applications. This decision is related to how a firm allocates its resources. The degree of market focus is defined as the number of markets to which a firm’s resources are allocated. Firm A’s focused selection implies the focused allocation of resources to specialise on particular markets. Expected consequences are a strong position as leader in this market, with unique and specialised competences, yet a risky reliance on the success of these markets. Firm D, on the other hand, invests time in numerous markets. The firm is not selective of applications. Although this approach enables flexibility and gives access to subsidised support, the firm may not develop unique competences and risk wasting resources on ‘dead end roads’.

The second variable concerns the content and timing of the first market application decision. It is related to the challenge of managing the long FC pre-commercialisation period. The decision is relevant because it says something about which firm will access a profitable market first. Firm A and Firm B have chosen for the same early adopter market: back-up power. The profitability of this application is calculable and the firms have received repeat orders from customers. The commercialisation of this application is, therefore, imminent. Firm C and Firm D have chosen for applications, a motorbike and a power plant respectively, with near-term potential. The technical as well as the economic feasibility of these applications still have to be proven.

Each case firm conducts similar FC development activities. The firms are small and have all been founded 5 to 10 years ago. Table 1 illustrates the firm characteristics. Firm A is focused on the development of fuel cell systems for onsite energy generation. The company develops and delivers end-products to end-users. It is currently targeting specific business to business markets for its back-up power products. Firm B targets early adopter markets for back up power as well as particular markets for fork lift trucks. The company supplies fuel cell modules, comprising of complete fuel cell systems to Original Equipment Manufacturers (OEMs). Firm C does not select particular market applications. However, the company has developed a fuel cell motorbike for demonstration and is now further developing this product. Firm D is focused on the development of fuel cell stacks, the main component of a FC system, than on the market application of its technology. The company targets the supply fuel cell stacks and conducts projects in a broad diversity of market applications.
The empirical research results are presented in four sections. Primarily, paragraph 4.1 provides an overview of how the fuel cell firms match their technology to markets. This section describes the considerations for a ‘good match’. Subsequently, differences and similarities between the case firms are described in three sections. First, the motivation and drivers for market selection are addressed and secondly, the observed determinants for the selection of markets are described. Lastly, quantitative findings supplement the qualitative results.

4.1 Match considerations
How does a FC firm match its technology to markets and in particular to customer demand? The interviews addressed the considerations and criteria for a good match. Each firm explained how a first evaluation of an application can be made to roughly determine its technical and economic feasibility. The price and performance of incumbent technologies in a particular market are used to benchmark and evaluate an application. This is a fundamental, and at least partly calculable, comparison of FC technology with the current alternatives. Subsequently it is not surprising that the case firms recognise the potential for fuel cells in similar markets and approximate a similar adoption order. The early markets for back-up power, fork lift trucks and later markets for heat and power appliances and mobility markets are well-known and eagerly discussed.

However, FC firms are uncertain when and which specific markets and market segments will adopt their technology. Firm A has done market research and determined its market focus through extensive conversations with potential customers. As Firm A states, “…at each client, whenever we talk about back-up [power]… we gain more knowledge … we also learn quickly which parts of those 6000 sites are economically profitable”. Firm B explains that “…it is difficult to know who really wants it”. This company states that it has to do demonstration projects in a particular market in order to understand which

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Firm A</th>
<th>Firm B</th>
<th>Firm C</th>
<th>Firm D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm size</td>
<td>330</td>
<td>325</td>
<td>70</td>
<td>25-30</td>
</tr>
<tr>
<td>Competence at founding</td>
<td>FC technology</td>
<td>FC test systems</td>
<td>FC technology</td>
<td>Materials, Akzo</td>
</tr>
<tr>
<td>Core FC business</td>
<td>FCs for onsite energy</td>
<td>Module production</td>
<td>R&amp;D</td>
<td>FC Stack production</td>
</tr>
<tr>
<td>FC supply</td>
<td>Back up and prime power</td>
<td>FC modules, stacks</td>
<td>License agreements</td>
<td>FC Stacks</td>
</tr>
<tr>
<td>FC Markets</td>
<td>Onsite power generation</td>
<td>Mobility, portable, stationary</td>
<td>CHP, aircrafts, remote power, automotive,</td>
<td>Portable, stationary and automotive</td>
</tr>
<tr>
<td>Targeted near-term market(s)</td>
<td>Telecom and cable back up, prime power remote locations,</td>
<td>Back-up power and fork lift trucks, portable power army</td>
<td>Premium consumer market</td>
<td>PEM power plant Fork lift</td>
</tr>
<tr>
<td>Demonstration</td>
<td>Home Energy system</td>
<td>Technology demonstrators mobility</td>
<td>ENV motorcycle</td>
<td>Buses, CHP</td>
</tr>
<tr>
<td>Power range</td>
<td>5kW</td>
<td>500W-65 kW</td>
<td>50W-75kW</td>
<td>500-20kW (stackable)</td>
</tr>
<tr>
<td>Other H Technology</td>
<td>Onsite H\textsubscript{2} generation</td>
<td>FC test stations, onsite H\textsubscript{2} generation,</td>
<td>Reforming, H\textsubscript{2} generation, storage</td>
<td>Reforming</td>
</tr>
</tbody>
</table>

Table 1: Characteristics of firms in the case studies
specific market and operational demands to target. The firms are looking for and learning about which specific markets match the performance of their current technology. This match requires an understanding of specific customer demands and the technology’s operational performance.

In order to predict how a firm’s technology will perform in operation, the firms have to gain practical experience and generate operational data. Firm A has generated a database of operational information from extensive field test experience. Firm D is conducting its first field tests: “...what it now really comes down to are field tests … you are really confronted will all kinds of things, because it is for the first time, it is new, it is different”. As Firm B explains: “...you have to do a demo first to know the real costs, the unexpected costs etc...”. To match the technology to a customer’s demands, the firms need to gain experience with operation in practice. Without operational information, Firm B explains, “…OEMs have too many questions that can not be answered with authority”. Thus, matching at firm level additionally requires validation and proofing of a technology, on the one hand, to know which customer requirements the firm can and cannot meet, and on the other hand, to answer a customer’s questions and doubts.

The FC firms acknowledge that customer’s are, more often then not, unfamiliar with fuel cell technology. As a consequence the firms have to educate customers and explain the technology. As Firm C states “... the frustrating thing is going out to customers and having to explain the technology”. Firm C has chosen to develop a ‘beautiful’ product in order to explain its technology: “… the beauty was a way of opening the doors so that people could understand the technology”. Firm A’s back-up power product cannot be prized through its beauty. The firm spends a lot of time to generate awareness among potential customers. Firm A also explains that “… you have to explain them just about everything about fuel cells”. It is, however a balancing act to enthuse customers without generating too high expectations. Firm D, aims to supply FC stacks, but is confronted with OEM customers that do not have the capability to develop and integrate a fuel cell system as yet. For that reason firm D has chosen to “... help system integrators on their way…”, by delivering or jointly developing a FC system. This last observation shows that a FC firm has to match the way it supplies its technology to the capabilities of a customer.

Finally, FC firms match their technology to markets at the level of customer requirements. The FC firms further design and specify their technology as customer requirements gradually become more concrete and clear. The FC firms manage this process in different ways. Firm B supplies a fuel cell module to customers, who provide feedback for module modifications or improvements. These OEM customers experiment with the integration of the module in their products. Currently, Firm D jointly specifies and develops a system with a customer OEM. By contrast, Firm A is responsible for an end-product that will not be introduced until the operational tests prove that customer requirements can be met. Similarly firm C explains that regarding the development of its motorbike, “…there are high expectations and we either have to satisfy them and launch or if we consider we can’t satisfy we won’t launch”. The supply chain position of the firm, therefore, determines how a customer’s requirements should be matched to the
technology. The match considerations described above suggest that a firm’s level of product-market experience and a firm’s supply chain position influence the process of finding a match.

4.1 Motives and drives

In matching their technology to markets, FC firms have made heterogeneous selection decisions. What are the motives behind the different market application decisions? The interviews reveal heterogeneous motives and drives (see Table 2). Firm A and B’s motivation for the development of fuel cell technology is driven by the perception of market demand. Firms B and C where founded with the motivation to develop fuel cell technology, driven by the perceived potential of the technology. These firms prioritise the development of hydrogen and fuel cell technology above the development of applications for their technology. By contrast, Firm A is highly focused on a near-term commercial roll out, motivated by the perception of market demand. Firm B targets a similar early adopter market based on perceived market demand, but is also driven by the possibility to achieve production volumes to validate the development of a production facility. Firms C is targeting the near-term development of the motorbike quite unexpectedly. The firm is motivated by immense consumer feedback to an earlier demonstration. “We cannot ignore the consumer” firm C explains. Firm D is developing a FC power plant, motivated to gain practical experience, achieve volumes and validate the technology.

Each firm is engaging in niche market applications. Firm A and B target commercially viable first markets in order to become profitable as soon as possible. Firm C and D appear to engage in niche market applications as a manner to bridge the period to mass market acceptance. The motivation to conduct and select demonstration projects is divers. Firm A has conducted demonstration projects with launching customers in order to prove the technology and convince the targeted market. Firm D’s motivation is also validation, but of their technology in general and to gain operational data. Firm B’s technology demonstrator strategy is motivated by the need to learn about “who really wants it”. Additionally, this strategy is used to validate and demonstrate their technology to a broad scope of potential OEM markets. Firm C’s demonstration project targets the broadest audience: “… I think that it was done because we needed a way of demonstrating to a wider public, that this technology was ready to rumble”. The demonstration is used to enthuse a broad public and as a tool to explain the technology. Firm C has chosen a complex product, to demonstrate their technical capability. The motivation for focused or

<table>
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<th>Table 2: Motives for market application decisions</th>
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<tr>
<td><strong>Motivation</strong></td>
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<tr>
<td>FC technology</td>
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<td>Near-term application</td>
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<td>Niche markets</td>
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<td>Demonstration project</td>
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<td>Product development</td>
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broad market selection and first markets appear to be related to a firm’s product-market experience with identifying customers. Additionally, the degree of learning appears to be related to a firm’s supply chain position.

4.3 Decision determinants

What firm characteristics influence a firm’s market application decisions? The similarities and differences between the case firms are summarised in table 3. First, differences in the firms’ application objectives were observed. Second, the interviews have shown variable levels of product-market experience. Finally, differences and similarities of firm resources were noted.

A difference has been observed in the degree to which a firm is concerned with the development of an application. Will the firm invest resources in the development of a product? This depends on the supply chain position of the firm and its historic ambition. Firm A supplies an end-product and has targeted on-site energy applications at founding. The other firms did not target any particular market applications at founding and aim to supply their technology to OEM customers. Firm C is an exception in that the firm is now committed to the development of the motorbike whilst it is structured as an R&D firm.

The case firms show a variable level of experience with the application of their technology. This variance appears to influence market application decisions. Several types of product-market experience were observed: field test experience, experience in demonstration projects, access to market information, experience with customer feedback and demand. A field test is a test of the performance of a new product under the conditions in which it will be used. The case firms all acknowledge that data on operational performance is essential in order to prove the technology to customer. Firm A has conducted extensive field tests with customers and generated a database of operational data for their back up power products. By contrast, Firm D is developing its first field test applications to gain practical experience and validate their technology in operation. Firm B is gaining field test experience in projects with OEM clients that actually overlap field tests and demonstration.

Demonstration projects involve the implementation of the new technology such that various stakeholders can evaluate and assess the value and merits of widespread application. Demonstration projects provide FC firms with valuable product-market experience. Firm A has conducted several demonstration projects with launching customers. Firm B has applied its module in numerous and diverse demonstration projects with customers. Firm C has gained extensive consumer feedback from its motorbike demonstration project. Besides, a group of supporters for this motorbike has formed in response to the demonstration. They provide a unique consumer base for market research.

Market research provides product-market experience to better understand customer needs and requirements. Firm A has conducted market research, in the form of conversations with clients, to determine its market focus. These conversations with clients are used, on the one hand, as criteria to test and develop their products and, on the other hand, to
specify in which specific applications their product is profitable. Firm A and B have received repeat orders for back-up power products. This explains why they have selected similar early adopter markets.

The resources of each firm, in terms of financial assets and capabilities, are variable. An obvious difference is the financial structure of the firms. Firm A and Firm B are publicly listed firms. Both explain that the financial market pressures the firms to become profitable as soon as possible. Firm C and Firm D depend on private investors and have fewer resources to spend. Regarding capabilities, the firms show similar capabilities for fuel cell stack design. Firm A differentiates itself with manufacturing capabilities, Firm B with its unique module / system design, Firm C with its innovative stack and system design, and finally Firm D with its stack expertise. Regarding market application capability, it is notable that Firm A and Firm D have hired an expert in the targeted market to bring their product to market.

<table>
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<th>Table 3: Similarities and differences</th>
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<td><strong>Objective</strong></td>
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<td>Supply chain position</td>
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<td>Products to B2B</td>
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<td>Modules to OEMs</td>
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<td>R&amp;D, IP licensing</td>
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<td>Stacks to OEMs</td>
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<td>Application objective</td>
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<td>End product</td>
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<td>Historic ambition</td>
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<td>Profitable FC products</td>
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<td>Hydrogen products</td>
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<td>Licensing of H₂ technologies</td>
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<td>Stack production</td>
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<td><strong>Experience</strong></td>
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<td>Field test</td>
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<td>Extensive, data base of 2 products</td>
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<td>Validating through tech. demonstrators</td>
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<td>Several projects for customer</td>
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<td>Initial application, validation</td>
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<td>Demonstration</td>
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<td>3 projects with launching customers</td>
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<td>Module applied in numerous projects</td>
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<td>Motorbike project</td>
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<td>Initial projects, Feasibility studies</td>
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<td>Source of market Information</td>
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<td>Conversations with clients</td>
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<td>Demonstration projects</td>
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<td>Motorbike supporters</td>
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<td>Clients that approach the company</td>
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<td>Customer feedback</td>
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<td>Repeat orders</td>
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<td>Repeat orders</td>
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<td>Reaction to motorbike</td>
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<td><strong>Resources</strong></td>
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<td>FC, manufacturing</td>
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<td>FC, stack</td>
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<td>FC stack R&amp;D</td>
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4.4 Demonstration experience

The interview findings suggest a variable level of product-market experience and resources. Data has been sought to support this observation. Demonstration experience has been quantified by the number of operational demonstration projects a firm has completed. This data has been collected from press releases. Resources, in terms of intellectual property, have been quantified by the number of patents a firm has. This data has been collected from the European database office.

The number of demonstration projects completed over the previous eight years by each firm is shown in figure 2. Firm A and B have started with operational demonstration projects years before firm C and D. Additionally, firm A and B have completed significantly more projects than firm C and D. The graphs suggest that Firm A and B have gained significantly more demonstration experience than firm C and D.

The total number of patents acquired over the previous eight years shows a large difference between firms A and B and firms C and D (Figure 3). Firm A shows a steady growth of patents as of 1998. As for firm B, the number of patents shows a steady growth since 2002. This period coincides with the development of Firm B’s module that has been applied a numerous technology demonstration projects.

5. Discussion

In the following paragraph the interview and literature findings are discussed to understand 1. how a firm matches it technology to markets and customers and 2. the variables that influence the match between a firm’s technology and its customers.

5.1 Matching

The literature review (paragraph 2) suggests that matching a technology to market involves an evaluation of a technology’s functions and performance with respect to consumer needs and requirements. In practice, the interviews demonstrate that a rational comparison between a technologies value proposition and the current alternatives provide a good indication of interesting markets. However, the FC firms show that it is challenging to determine which specific market segments and customers to target. As innovation studies suggest, FC firms do not have a clear understanding of customer

1 http://www.european-patent-office.org
needs. Besides, FC firms show that the performance of their technology in operation may not be explicitly known. Two FC firms conduct demonstration projects to learn and ‘look for’ a match between the operation of their technology and the operations to target. Two FC firms learn which applications are profitable through conversations with possible customers. It is challenging to identify the customers that are willing to pay for the current operational performance of the technology.

A second consideration (figure 4) to apply a technology in markets involves communication and education with respect to a customer’s understanding and expectations. The literature review suggested that a customer’s unfamiliarity with a technology generates uncertainty and influences market adoption. Strategies may be applied to reduce this perceived risk of adoption. The interviews show that FC firms educate customers to create awareness and enthusiasm. The firms supplying end-products are challenged to carefully manage customer expectations. The FC firms that supply systems to OEMs educate their customers on product integration. Firm B has developed a near ‘plug and play solution’ and Firm D provides system integration services. As the literature review suggests, reducing the perceived complexity and uncertainty of a technology, will increase the rate of adoption. A third consideration is, therefore, to match the technology supplied with the product integration capabilities of the customer OEM. The last consideration of matching a technology to markets at firm level involves design and development. Product development literature states that a system or product should be designed to meet customer’s requirements. The FC firms design systems and products according to customer requirements and customer feedback is used to further optimise the fit with customer requirements. In the case of end-products, design is targeted to compete with the current alternatives. In the case of OEM customers, systems are often developed jointly. Matching a firm’s technology to customer requirements is a gradual process of alignment.

5.2 Matching variables
The literature review in paragraph 2 describes strategic decisions and several variables related to the success of a new technology and a high technology firm. Entrepreneurial ambition, resources, capabilities and prior experience are expected to influence strategic decisions and their success. The interviews with fuel cell firms reveal motives for the selection of market applications including internal learning and external communication. A firm’s application experience and its supply chain position appear to be determinant for the selection of market applications.

FC firms that supply a FC system to OEM customers, responsible for product integration, select a broad scope of applications to engage in. Strong motivations are, 1. to learn which customers to target and, 2. to show potential customers that their system can be applied in
many different products. FC firms that supply end-products to customers have focused on select market applications. Their resources are focused on bringing their product to a specific market. These FC firms are motivated by a strong perception of customer demand. Regarding the second dependent variable, there are two firms that have recognised a commercial early market. These firms appear to be ‘market driven’ as they develop FC technology and applications in reaction to a perception of market demand. Additionally, these firms appear to have gained more product market experience and resources than the other two firms. These observations suggest a difference in phase of development. As scholars suggest, small high technology firms must evolve from a technology drive to a market led management (Balachandra e.al. 2003, Berry 1996, Kakati 2003).

Matching at firm level depends on the technology that particular firm supplies and the respective customer’s familiarity with the technology. To identify customer demand and understand customer requirements a firm needs product-market experience (Figure 3). The required level and type of product-market experience appears to depend on a firm’s supply chain position. For the supply of a system there are many possible OEM customers. Additionally, operational performance of the technology is uncertain until applied in an OEM’s product. Besides, an OEM customer may be uncertain about its capability to integrate the system into its products. By contrast, for the supply of a product, the scope of potential customers is already limited. The product can be optimised according to the requirements of the targeted customer group, prior to introduction. Thus, a firm requires more product-market experience, through collaboration with customers, to match its technology to OEM customers. The required level of application experience additionally depends on the familiarity and capabilities of a customer.

Concluding, there appears to be a relation between a firm’s product-market experience and its ability to recognize profitable markets and customer demand. Scholars have argued that a firm’s assets often develop as a function of its different experiences (Barnett and Hansen 1996, Ingram and Baum 1997). In line with the resource based theory of the firm, this paper, therefore, suggests that product-market experience is a source of competitive advantage. This paper presents preliminary findings. Further research will examine this relation through a second round of interviews. Besides, the research requires more data of the case firms, such as such as patents and financials, to argument the findings.

Figure 3: Determinant factors of a high technology firm for matching a technology to markets.
6. Literature
THE ROLE OF SOCIAL NETWORKS IN FINANCING HIGH TECHNOLOGY NEW VENTURES: AN EMPIRICAL EXPLORATION

JORIS HEUVEN
University of Twente
NIKOS
Capitool 15
Enschede, The Netherlands, 7500 AE
Tel: (+31) 53 - 4895355
Fax: (+31) 53 – 4892159
e-mail: j.m.j.heuven@utwente.nl

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Enschede
The Role of Social Networks in Financing High Technology New Ventures: An Empirical Exploration

ABSTRACT

This paper focuses on the role of networks in financing high technology start-ups. We claim that the role of networks is twofold. On the one hand networks are important because network contacts can give direct access to resources. On the other hand, networks are important because being affiliated with prominent partners can send important information signals to financial resource providers. In this paper we focus in particular on a special type of signal, being the referral. The dual role of networks is studied in four high technology start-ups using a social systems approach. Our results show that start-ups in early development stages that have little experience and knowledge more often use referrals in accessing financial resource providers. They seem to profit from a network rich in structural holes and many strong connections in getting financed. Added to these findings, we found that strong ties are more often activated as a referral source than weak ties. On the other hand, the more experienced entrepreneurs/start-ups in latter development stages access financial resource providers more direct without using referrals. They seem to profit from a network rich in structural holes combined with many weak ties.

INTRODUCTION

The uncertainty and lack of information that surrounds new ventures complicates the acquisition of resources needed to build and grow ventures. Stinchcombe (1965) refers to these complications as ‘the liability of newness’. The specific focus we apply in this paper is on the acquisition of financial resources. We argue that social networks play an important role in new venture financing. The role of networks in financing new ventures is twofold. On the one hand networks are important because network partners can directly provide resources to the firms (direct network effect). For example many entrepreneurs acquire substantial financial resources through direct relations with friends or family. However, networks are also important in a second way because being affiliated with (prominent) partners can be an important information signal to financial resource providers (indirect network effect). In this paper we predominantly interested in a special type of indirect network effect, namely when a (prominent) partner acts as a referral source to financial resource providers.

In this paper we research the dual role of networks from the perspective of the new venture. We research which relational and positional network characteristics are most effective for getting financing. This approach is twofold. First we research how new venture get access to financial resource providers. Second, in order two research our second network effect, we also research how prominent partners in general are found and accessed. Subsequently we research how the prominent network partners play a role in the financial resource acquisition process, primary by focusing on referral mechanisms. In our research the 4S model is our central theoretical framework. This multi dimensional process model of firm development is well suited to study networks in an entrepreneurial setting. Based on this model propositions are shaped and tested through case studies using a sample of four high technology start-ups.
Our results show that more experienced entrepreneurs/start-ups in latter development stages don’t use explicit referrals in accessing financial resource providers. They seem to profit from a network rich in structural holes combined with many weak ties. On the other hand, start-ups in early development stages that have little experience and knowledge more often depend on referrals in accessing financial resource providers. They seem to profit from a network rich in structural holes and many strong connections in getting financed.

LITERATURE REVIEW

Networks in Entrepreneurship

In previous entrepreneurship studies researchers put much effort in researching the effects of network ties on the behaviour of both individuals and organizations (Adler & Kwon, 2002; Aldrich and Zimmer, 1986; Birley, 1985; Burt, 1982, 1992, 1997, 1999, 2000, 2005; Coleman, 1972, 1988, 1990; Elfring, Scholten, Kemp, & Omta, 2002; Florin, Lubatkin, & Schulze, 2003; Granovetter, 1973, 1985, 1992; Groen, 1994, 2000, 2003, 2005; Groen et al., 2001, 2002; Groen, Jenniskens, & van der Sijde, 2005; Gulati, 1998; Harveston, Wakkee, van der Sijde, & Groen, 2004; Hite & Hesterly, 2001; Hulsink & Elfring, 2003; Kirwan, van der Sijde & Groen, 2005; Klein Woolthuis and During, 1997; Klein Woolthuis, 1999; Klein Woolthuis, Groen & During, 2001; Mitchell, 1969; Nahapet & Ghoshal, 1998; Powell, 1990; Powell & Smith-Doerr, 2003; Rowley, Behrens, & Krackhardt, 2000; Stinchcombe, 1965; Uzzi, 1997, 1999; van der Veen & Wakkee, 2004). Researchers in the past have provided mixed results in defining optimal network positions and relations. For example Burt (1992) claims that individuals and teams that are embedded in sparsely connected networks enjoy efficiency and brokerage advantages because of non-redundant information exchanges. On the other hand, Coleman (1990) argues that dense connections between members of a network lead to cooperative behaviour, which provides many advantages over sparsely connected networks. Other researchers who apply a more relational network approach claim that a mix of weak and strong ties is the optimal configuration. For example Uzzi (1997, 1999) states that the ideal network includes a mix of strong and weak ties. A relational governance of strong ties promotes the development of trust, the transfer of fine-grained information and tacit knowledge, whereas weak ties increase diversity and may provide access to new information and opportunities (Granovetter, 1973, 1985, 1992). Researchers specifically focusing on business start-up networks claim that the optimal relational and positional characteristics of the start-up network are dependent on the specific organizational process (Hulsink & Elfring, 2003) the life cycle stage a start-up is in (Hite & Hesterly, 2001) and the type of technology that is being commercialized (Groen, 1994, 2000, 2005)

Networks and Resource Acquisition

Closer to the subject of our study, there is research conducted that focuses on the role of networks on resource acquisition at new ventures. Resource acquisition is one of the key processes of entrepreneurship (Greene, Brush & Hart, 1999; Hulsink & Elfring, 2003). Researchers have made claims on the range of resources a new venture needs, however our research model will come up with its own classification of resources. Many researchers focus on the role and importance of networks in the acquisition of the wide range of resources (Jenssen, 2001; Jenssen & Koenig, 2002; Larson, 1992; Starr & Macmillan, 1990; Uzzi, 1997, 1999; Wilson and Appiah-Kubi;
Financing through Networks
Many researchers focus on the options that entrepreneurs have in financing their ventures and their consequences for success. For example, Bates (1997) finds that entrepreneurs prefer to rely on family wealth and loans and Colombo and Grill (2005) found that start-ups that received private external equity financing have greater start-up sizes. Next to studies from an entrepreneur oriented perspective, a huge part of literature is conducted from an investor’s perspective (i.e. Fried & Hisrich, 1994; Gupta & Sapienza, 1992; Hall & Hofer, 1993; Maula, Autio & Murray, 2005; Zacharakis & Meyer, 1998). Researchers in this stream of literature mainly focus on the psychology and decision criteria of financial resource providers. In our study we have a specific focus on the role of social networks in new venture financing. In the current literature, some examples of researchers that focus on the direct effect of networks in financing can be found. For example, Chang (2004) shows that more successful start-ups have larger networks and have ties to prominent venture capitalists and partners. Zhao and Aram (1995) show that entrepreneurs who are more active in ‘networking’ are more successful.

Networks as a Status/Referral Source for Financing
Next to the direct provision of resources by network partners, we also focus on a second network effect in the provision of financial resources. The assumption underlying this second network effect is that being related to prominent partners increases the status of a new venture and therefore decreases the uncertainty as perceived by financial resource providers. Applications of the status concept in entrepreneurship studies is limited (Washington and Zajac, 2005), however applications of the concept can be found in related fields. Researchers in these fields do recognize the value of a more sociological approach to markets and competition (Burt, 1982, 1992, 1997, 1999, 2000, 2005; Granovetter, 1973, 1985, 1992; Parsons & Smelser, 1956; Rangan Insead, 2000; Simon, 1976; Uzzi, 1997, 1999). In management and organization literature, we found several definitions of status (Perrow, 1961; Podolny, 1993, 2001; Weber, 1922). In all definitions the role of networks is recognized. Researchers who research the role of networks in the status building process come up with relatively general assumptions on the effects of networks on status. One of these fundamental assumptions on status is that status ‘flows’ through network ties (Lai, Lin, & Leung, 1998; Lin, 1999; Benjamin & Podolny, 1999).

The status concept as introduced in the previous section allows us to introduce the second effect of networks on the acquisition of financial resources, labeled as the indirect network effect. The indirect network effect can be described as an increase in strategic capital (status) through social networking (links to prominent players) which enables the firm to acquire economic resources more easily. There are some studies that focus on indirect network effects in new venture financing. These researchers mainly focus on the role of status, reputation, referrals and endorsements in financing. For example, Shane and Cable (2002) claim that the networks are important to new venture financing because they transfer information and therefore decrease the
perceived uncertainty of resource providers. Stuart et al. (1999) focused on the referral network effect by studying the effects of endorsement on the performance of biotechnology start-ups. They show that privately held biotech firms having prominent strategic alliance partners and organizational equity investors go to IPO faster and earn greater valuations than firms that lack these connections.

In his paper we focus in depth on one type of indirect network effect, being the referral. We assume that a connection with a high status partner is most favorable when the partner acts as an explicit referral source for the new venture. In literature there are some studies conducted that focus on referrals and new ventures. One interesting finding can be found in Aram (1989); he claims that informal investors prefer referrals of business service professional over referrals of friends. Another finding is that endorsements of high partners are particular valuable in areas in which the high status affiliates are perceived to have expertise (Baum, Calabrese, & Silverman, 2000; Goode, 1978; Reuber & Fischer, 2005; Stuart, Hong, & Hybels, 1999). This last finding implies that there are interaction effects that determine the effectiveness of social capital. Related to this finding, Fried and Hisrich (1994) found that although many VC financing proposals come without introduction, most funded business proposals come by referral. In our literature review we found that very little studies explicitly focus on positional and relational network characteristics and referrals. Two of the few studies that do so are the ones of Batjargal (2005) and Batjargal & Liu (2004). In these studies support was found that strong ties between the new venture, venture capitalist and the referral source have favorable effects for the venture in getting funded.

What do we need?
The literature review provides some insight in the relevant literature for answering our research question. However some gaps and shortcomings can be identified. Most research applying a network approach focuses on direct network effects. However there is still much work to be done in searching for contingencies that determine the effectiveness and value of certain network characteristics. (Higgins & Gulati, 2003, 2006; Leenders & Gabbey, 1999; Shane & Stuart, 2002). The second network effect, the indirect effect of networks, is studied less extensive. The specific positional and relational network configurations that lead to for example an optimal status/referral effect of networks are poorly studied. More research on this indirect network effect will provide a more complete understanding of the role networks play.

The research model we apply should therefore meet several requirements. First the model should provide a base to study direct and indirect network effects. Second it should provide a theoretical base to check the contingencies that play a role. Third, since we focus on financing issues over time, it must be suited to apply a longitudinal process oriented approach. In the next section we explain how our model can meet these requirements.

RESEARCH MODEL

4S Model
Entrepreneurship is a field that still lacks coherent frameworks which enable multidimensional and multi level analysis of the phenomenon (Davidsson, 2004; Shane & Venkatamaran, 2000; Van der Veen & Wakkee, 2004). In order to overcome
the lack of a central framework, the 4S framework is developed by Groen (1994, 2000, 2005) in order to provide a theoretical foundation to research entrepreneurship. The origins of the 4S model lie in the work of the functionalist sociologist Talcott Parsons (1937, 1964, 1977). Parsons claimed that in every social system four mechanisms can be identified. (1) In every social system there is interaction between actors who (2) strive for goal attainment. (3) Additionally, these interacting actors try to optimize their processes. However, (4) in order to make interaction possible, there have to be some common patterns of culturally structured and shared symbols. The central hypothesis is that in order for a social system to survive (so as well for a new venture); the social system has to have sufficient performance on all of these four mechanisms. The 4S model is the central theoretical framework that we apply in this paper in order to study entrepreneurial processes. Entrepreneurial processes are defined in this context as processes in which an entrepreneur sees a business opportunity, develops it into a business concept and brings it into exploitation (Groen, 1994, 2000, 2005).

Groen has translated the four basic mechanisms of a social system to an entrepreneurial context, resulting in four dimensions and related capitals of the 4S model. The central hypothesis of the 4S model is that a company needs ‘sufficient’ capital on the four dimensions in order to survive. In short, this means a company needs four different capitals namely strategic, economic, cultural and social capital. Strategic capital refers to the goal attainment dimension, economic capital to the optimization of processes dimension, cultural capital to the pattern maintenance dimension and social capital to the interaction dimension. The 4S model provides a theoretical foundation for studying entrepreneurship in a systematic way and provide a valuable framework in order to position research and shape research questions. An important remark on the four dimensions is that they do not exist in isolation. The four dimensions interact through the social network dimension. This interaction between dimensions allows a dynamic analysis of the four dimensions. For a more extensive outline of the 4S framework and examples of studies and research questions following from the framework we refer to Groen (2005).

We now show how the 4S model can be used in researching the direct and indirect effects of social networks in new venture financing. In doing so, we divide the effect of networks in several subsequent sub processes which can be studied separately. The following figure provides a guide in order to explain the different sub processes.

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Insert Figure 1 about here
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In the figure three actors are visualized. These three actors all bring their four capitals of the 4S model in interaction through the social network dimension. By visualizing the four capitals for all actors we get a good overview of the complexity and different factors that influence the acquisition of financial resources in new ventures.

The figure can provide a good framework in order to explain the relevant sub processes in answering the research question. The starting point for of the financial resource acquisition process is a start-up identifying and connecting to financial resource providers. The origin of this tie can be diverse. Start-up entrepreneurs can for
example bring financial resource providers to the firm through previous jobs, education or contacts in the private sphere. However, this tie can also be formed after start-up through a direct approach or through brokerage by other contacts. The next step in the model is a start-up identifying and connecting to prominent partners. Again the origins of these contact can be diverse. The last step concerns the actual decision of the financial resource provider to provide financial resources to the new venture. In this step the financial resource provider makes a decision to provide economic resources based on the information he has available. Part of this information is the status (strategic capital) of the new venture resulting from the connection/referral with the (prominent) partner, labeled as the indirect network effect. In this paper we focus in depth on type of an indirect network effect, namely a (prominent) partner acts as a referral source of the new venture.

By focusing on the start-up, financial resource provider and referral triangle we are able to get a better understanding of the direct and indirect role of networks in financing. The arrows between the actors represent the (potential) ties between the actors. By studying the network relations and positions within the triangle, we can identify interaction effects that determine the prominence of direct and indirect network effects in new venture financing.

PROPOSITIONS

**Burt or Coleman?**

In this section we concretize the model one step further by shaping propositions on the role of the network in the different sub processes as derived from our research model. Past research has provided mixed results on the effectiveness of strong vs. weak ties and dense vs. loosely coupled networks in (financial) resource acquisition. One of the central discussions on the effectiveness of networks is between Burt and Coleman, who both have different views on the mechanisms that foster an optimal network configuration.

On the one hand there is Burt (1982, 1992, 1997, 1999, 2000, 2005) who claims that optimal network value is created through structural holes. The structural holes argument claims that a certain actor can create value by brokering connections between segments that would be unconnected otherwise. Such a network provides unique information and control benefits to that actor. On the other hand, Coleman (1972, 1988, 1990) claims that network value is not created through structural holes but through dense networks and redundant ties. These network configurations improve the reliability of information because the same information can reach on actor from different sides, therefore creating value. Because dense and redundant networks increases trust and reliability of information within the network, actors in the network are more committed in doing a good job. For both Burt and Coleman the assumption is that the time and money of actors is limited. Therefore an actor has to make choices in configuring their network.

In the next section we shape propositions on the effectiveness of weak vs. strong ties and positional vs. cohesive network configurations. We shape propositions following the sub processes of our research model. In some sub processes the Burt and Coleman discussion is less relevant. In that case we turn to other research in order to be able to shape propositions.
Propositions
The first step in our research model is a start-up getting connected to financial resource providers. Therefore our first propositions focus on this sub process. The connection between a new venture and a financial resource provider can have many origins. A company can be connected to a financial resource provider through previous jobs, education or private connections. However a start-up can also intentionally search for financial partners. In this case, two conditions have to be met. On the one hand, the start-up has to know what the financial options in the market are and second, the venture must be able to get in contact with the financial partners. For the first condition Burt would argue that start-ups having networks with many structural holes have access to more diverse information. Therefore these start-ups are better able to identify the potential financial partners and opportunities in their market. Coleman on the other hand stresses the value of trust and commitment in networks. Following his rationale one could reason that a start-up in dense networks will be informed more honest and accurate about the financial opportunities and resource providers. This will be the case because in dense networks the penalty for false and incomplete information will be higher. Since Burt and Coleman have different views on this process, the following contradicting propositions are shaped.

Proposition 1a (Burt). Start-ups having networks rich in structural holes are better able to identify various financial options and financial resource providers.

Proposition 1b (Coleman). Start-ups in cohesive networks are better able to identify various financial options and financial resource providers.

After having identified the financial options, a start-up has to connect to the financial partners. Following the pure logic of Burt, access to financial partners will be most effective through weak ties. Burt argues that under the assumption that time and resources are scarce, a network with weak ties that span structural holes will be most effective. For this step in our research model Coleman would disagrees with Burt on the strength of tie argument. Since Coleman stresses the importance of trust and commitment, he will assume that strong ties are more helpful in accessing financial resource providers. Strong tie partners will be more committed and will better be willing to put ones name at stake for the start-up. Next to the commitment of strong ties, Brown & Reingen (1987) come up with another rationale why strong ties a favorable in getting access to people through referrals. They studied the referral behavior in a consumer setting and found that strong ties are more often used for referral behavior. It is striking that Burt (1998) in one of his studies argues that it is ineffective for low status/illegitimate actors to broker their own networks. For these actors it is more effective to “borrow” social capital of their network partners. In that case strong tie network partners are activated to help in getting access to unconnected resource providers. However for the purpose for our study, we would like to test the opposing views of Burt and Coleman. Therefore the following propositions are:

Proposition 2a (Burt). Start-ups having networks with many weak ties are better able to access financial partners.
Proposition 2b (Coleman). Start-ups having networks with many strong ties are better able to access financial partners.

In the next process of the research model the start-up identifies prominent partners. For the purpose of this paper we theorize on the situation of relating to unconnected prominent partners. The identification of prominent partners follows a similar logic as identifying potential financial partners. Again Burt will argue that start-ups having networks rich in structural holes are better able to identify the prominent partners. The many structural holes will function as a diverse pool for information on prominent partners. In Coleman’s rationale trust and reliability play a more prominent role. Coleman would argue that start-ups in densely connected networks are therefore better able to identify prominent partners. Since Burt stresses the value of diversity of information and Coleman the importance on reliability the following contradicting propositions can be shaped.

Proposition 3a (Burt). Start-ups having networks rich in structural holes are better able to identify prominent partners.

Proposition 3b (Coleman). Start-ups in cohesive networks are better able to identify prominent partners.

After having identified prominent partners, a start-up has to get access to them. Burt would argue that weak ties will be more effective in doing so that strong ties. The underlying rationale is similar to getting access to financial partners. The claim of Burt is supported by a study of Lin (i.e.1999). Lin theorizes on the effectiveness of weak ties by claiming that getting access to actors higher in a hierarchy is better realized through weak ties. Two actors having a strong tie are mostly considered to have a similar social status, so in order to connect to higher status actors weak ties are required. Coleman will stress the importance of strong ties in getting access to prominent partners because they will be more committed in helping the start-up. Several findings in related fields support the positive effect of strong ties in getting access to prominent partners. For example in a job market context Wegener (1991) found support that strong ties are favorable for low status actors in getting access to high status actors. Lin (1999) provided a review of studies on networks and social status and found mixed findings on tie strength and attained social status. Brown & Reingen (1987) studied the referral behavior in a consumer setting and found that strong ties are more often used for referral behavior. Since Burt and Coleman follow different rationales for getting access to prominent partners, the following propositions are shaped:

Proposition 4a (Burt). Start-ups having networks with many weak ties are better able to access prominent partners.

Proposition 4b (Coleman). Start-ups having networks with many strong ties are better able to access prominent partners.

We now are at the point that a new venture has a relation to potential financial resource providers and relations to a prominent partner. We now focus on the question
how and if the relations with the prominent partners are explicitly used to convince the financial resource provider. In this paper we are mainly interested in one role a (prominent) network partner can play in the financing process, namely acting as a referral source. For this question we follow a claim of Coleman. He claims that strong ties are more committed in helping the start-up through referrals. Added to this, Brown & Reingen (1987) found that strong ties are more often activated for referral behaviour than weak ties. It’s interesting to note that this logic not only holds for referrals of prominent partners but as well for other referrals. Therefore proposition 5 can be stated as follows:

Proposition 5a (Burt). Weak ties will be more often explicitly activated as a referral source than strong ties.

Proposition 5b (Coleman). Strong ties will be more often explicitly activated as a referral source than weak ties.

We assume that the strength of the tie between start-up and financial resource provider has implications for the effectiveness of referrals. We don’t have a specific assumption on the strength of tie between venture and resource provider, however the strength of tie has implications for the prominence of the referral network effect. When a new venture has a strong tie to the financial resource provider we argue that the referral effect of networks is lower. In that case the financial resource provider will have more direct information on the venture and will therefore rely less on other information sources like referrals.

Proposition 6. A referral will have less impact when the tie between the financial resource provider and start-up is strong.

The strength of the ties between the new venture and referrers (not necessarily a prominent partner) has implications for its effect on a given investment decision. Past studies assume that the stronger the tie between venture and prominent partner or other referral source, the higher the referral network effect in financing decisions will be. A strong tie to a high status partner means that more status will “flow” to the new venture (Lai, Lin, & Leung, 1998; Lin, 1999; Benjamin & Podolny, 1999). The study of Batjargal (2005) also found support for the effectiveness of a strong tie between prominent partner/referrers and start-up for a referral. The logic so far supports the claim of Coleman on the effectiveness of cohesive and strong tie network configurations. However the logic of Burt could also provide some value here since strong ties face down sides as well. Burt would argue that prominent partners/referrers having a strong tie to a new venture will be biased towards a positive referral on the venture. There are situation in which a referral of a weak tie will be more influential than a referral of a strong tie. In showing this we will take the example of a father who tells at work that his son is a very talented soccer player. Since almost every father wants his son to be a talented soccer player most colleagues will doubt the actual talent of the son. However when the same man is not the father of the boy but an official scout of the soccer association telling about a boy he saw playing at a game last weekend his colleagues will not doubt the talent of the boy. Therefore proposition 7 a + b are as follows:
Proposition 7a (Burt). A referral will have more impact when the tie between a start-up and the referral source is weak

Proposition 7b (Coleman). A referral will have more impact when the tie between a start-up and the referral source is strong

DATA

Method
The application of network theory to the direct and (even more) the referral network effect in financing new ventures is in a start-up stage. Therefore sources to construct propositions on these two network effects in an entrepreneurial setting are scarce. Therefore the propositions in the previous section are constructed with help of general network theories or applications of the concept in other fields. In particular for propositions on the referral effect of networks, marketing and job search studies provided a valuable reference source. However there is still much uncertainty about the effectiveness of certain network relations and positions in getting financing. Therefore we see case study research as a valuable first step in exploring our propositions (Yin, 1994). The cases will provide more understanding of the mechanisms and rationales that play a role and which network characteristics are more effective in getting financing. On its turn the case studies can provide a base for a quantitative study.

There were several criteria in selecting our cases. In general, the start-ups we focus on can be labeled as front end technology-based firms (Groen, Jenniskens, & van der Sijde, 2005). These companies share some common characteristics like high technology uncertainty and have a huge need for financial capital. Subsequently we selected cases that are based in the Netherlands and have a special interest in the first 5 years of start-up. For this paper we studied a total of four cases.

Case A is a company founded in 1999 by two young entrepreneurs with a technology background and little business experience. In the early stage, the company was supported by the university’s business development program. However, after a short while this help was not needed any more. The entrepreneurs quickly developed networking skills and won several prices for innovation and new business. Currently the company has 25 employees.

Case B is a company founded in 2001 by an entrepreneur with over 20 years of technology and business experience. Before starting the entrepreneur had already a large network in the relevant market. His network and reputation had a large impact on the development of his company. Currently the company has about 20 employees.

In 2004 Case C was founded as a spin-off of three companies. The owner had little business experiences and a moderate technology background. For its development, the company heavily relied and still relies on the parent companies. Currently the company has three employees.

Case D is founded in 2004 by an entrepreneur with moderate business and extensive technology experience. The entrepreneur had a large network at start and had much experience in applying for government grants. Therefore the entrepreneur was able to
finance his company solely on private investments and government grants. Currently the company has 2 employees.

**Data sources**

Table 1 provides an overview of the different data sources we used in collecting our data. A first step in constructing the case studies was an exploration of the companies’ websites and other online sources. Additionally, we had TOP files' available for two companies. These files were an additional source in order to construct a first picture of the start-ups. Subsequently we asked the companies to fill in the Monitor Technostarter, which is constructed based on the 4S model. Using this monitor helped us to get much data and a complete overview on the central elements that play a role in starting a business as derived from our fundamental theoretical model. Finally we interviewed the entrepreneurs in order to be able to ask specific questions on the role that networks play in financing there business. After the interview, the entrepreneurs were asked to fill in a short questionnaire to score the strength of relations they had to people they mentioned during the interview.

Using measures during the interview

The focus of this paper is on the effectiveness of structural holes vs. closure and weak vs. strong ties in financing high technology start-ups. However since we intend to extend the findings of this case study paper to a larger data set, we choose to use existing measures that are used to measure these network characteristics. First, it will give us some guidance to score multiple network characteristics, and second it will help us to reflect on these network measures. For the positional part of the network we chose to use the network tool of McEvily and Zaheer (1999; Scholten, 2006). This tool asks entrepreneurs to mention five or less people they turn to for advice on business issues and if these people are related. We extended this tool by asking the entrepreneurs to score how well these people know each other on a five point scale. We recognize that asking the entrepreneurs to score the strength of relations between their information sources on a five point scale can be arbitrary, however in a case study setting we assume that it can provide interesting insights.

For the relational discussion we decided to use the many used assessment of tie strength by Granovetter (1973; Scholten, 2006). This measure gives an indication of tie strength by asking questions on intimacy, frequency and length of contact. In this case study we will as well try to test the value of these three different variables on the acquisition of financial capital. For example it could be that for example intimacy is much more effective than for example length of relation. The assessment of the relevance of the different variables will enable us to select the most relevant variables for our quantitative study later on.

**RESULTS**

In this section we will discuss the findings resulting from the case studies. The findings in the case studies are summarized in table 2-13. These tables can be found at
the end of this paper. Based on these results we will discuss the findings per proposition as constructed in a previous section of this paper.

Proposition 1a (Burt). Start-ups having networks rich in structural holes are better able to identify various financial options and financial resource providers.

Proposition 1b (Coleman). Start-ups in cohesive networks are better able to identify various financial options and financial resource providers.

The first set of propositions deals with the effectiveness of structural holes vs. closure in discovering financial opportunities. First of all our results show that the positional network configuration of a start-up company is heavily dependent on the entrepreneurs personal network before starting and the development stage of the company. The entrepreneurs of case B and D both had substantial working experience in the market where they started their company. Therefore their networks when starting their business could be described as big and diverse. They both had extensive contacts in business & technology. In theoretical sense we would label their networks as structural hole networks from start. However when looking at financing their business both entrepreneurs indicate that they don’t consult external sources on financing issues. When looking at the finance structure of case B we see five different types of funding, being quite diverse. Case D however has only one source of external financing, however this is not because they were not able to identify other finance opportunities but because the entrepreneur didn’t want others to finance. The entrepreneur in case D is experienced in getting government grants and was and is able to finance his company with grants 100%, although other parties wanted to invest.

The network of case A could be labeled as a small closure network when starting. The entrepreneurs started from a PhD position and had little industry experience. However, they where very focused on expanding their network from start in diverse directions and were successful in doing so. The older the company got, the more the company can be labeled as having a structural hole network configuration. When looking at its finance structure one will see that they use 6 different sources of financing, being a diverse set of financial sources. For the identification of financial opportunities the entrepreneurs turns to the participation company, the bank and an informal investor. The network of case C can be labeled as small, homogeneous and interconnected. In theoretical terms it could be labeled as a closure network. From start it heavily depended on its three shareholders and is still doing so for access to finance. When analyzing the finance structure of case C you see that its financing is quite homogeneous. The entrepreneur indicated that he wants to grow fast, however besides of a bank loan and government grants he was not able to identify or access other finance sources.

In conclusion we argue that for the identification of financial opportunities, spanning structural holes are more effective. In concluding this we take the number of different finance sources as an indicator for the ability to identify financial opportunities. Those cases spanning structural holes have more diverse financing (except case D, but this had an other reason) than case C, which could be labeled as having a clique network. Therefore we conclude that for this process proposition 1a has more explanatory value than proposition 1b.
Proposition 2a (Burt). Start-ups having networks with many weak ties are better able to access financial partners.
Proposition 2b (Coleman). Start-ups having networks with many strong ties are better able to access financial partners.

For the purpose of this set of propositions I distinguish between two types of financial resource providers. First I will focus on the resource providers accessed with help of a referral and second I focus on financial resource providers accessed without help. For this set of propositions the situation when a start-up was connected to a financial resource provider before starting the business is less relevant. The two companies started by “inexperienced” entrepreneurs more heavily depend on referrals in accessing financial resource providers. The lack of experience, a network and legitimacy/status in the market didn’t allow them to access financial resource providers as easy as their “experienced” counterparts. In Case A and C (the inexperienced entrepreneurs) we identified 6 financial decisions in which a referral played a role. The contacts with these referrals were scored as somehow/very intimate and were quite frequent (1/week or 1/month). So for start-ups having little experience and legitimacy/status in the market strong ties seem to be more favorable in accessing financial resource providers, hereby providing support for proposition 2b.

For the two companies that are started by “experienced” entrepreneurs, a different logic seems to be effective. Both case B and D had a large and diverse network from start and had legitimacy/status in their market. Therefore they weren’t dependent on referrals in getting access to financial resource providers. The logic in accessing financial resource providers is mostly that the tie starts with a weak tie through an encounter at for example a conference or on initiative of the financial resource provider and develops gradually to a strong tie. A similar logic can be found at case A now, because at the moment they have built a substantial track record to be able to access financial resource providers themselves. Therefore our findings show that for “experienced” entrepreneurs and start-ups in later stages of their development, weak ties are more effective in accessing financial resource providers than strong ties. Hereby providing support for proposition 2a.

Proposition 3a (Burt). Start-ups having networks rich in structural holes are better able to identify prominent partners.
Proposition 3b (Coleman). Start-ups in cohesive networks are better able to identify prominent partners.

In discussing proposition 1a and 1b we already gave a typology of the positional network characteristics of our four cases. We identified case B and D as having a network rich in structural holes from start. Case A is a start-up that started form a closure situation but was very rapidly able to change their network into a situation which can be considered as a network spanning structural holes. Case C started and still is in a closure situation. When the entrepreneurs were asked to explain how they met prominent partners one could see differences between the answer between the structural holes type of network and the closure network. Although the entrepreneurs (In particular in case B and D) stressed the importance of coincidence of getting connected to prominent partners, they are really actively going out to conferences and trade shows. So one could not push the process of getting aware and in contact to
prominent partners, however you can intentionally put yourself in the situation were “coincidence” is more likely. On the other hand, the entrepreneurs with a more closure type of network (A in the beginning and C) are less active in going to conferences and trade shows but rely on general source like the internet in identifying prominent players in their market.

So there is a difference in identifying prominent players between a structural hole and closure type of network. When analyzing the number of prominent partners a start-up actually has differences can be identified. Both case B and D were able to mentioned a large number of prominent partners in a diversity of areas (business, universities etc.) they were connected to. When looking to the diversity of prominent partners, one could not see large differences. However a structural hole network type seems to be favorable to identify a larger number of prominent partners. Therefore we argue that proposition 3a has more explanatory value than proposition 3b in this process.

In our case studies we were not able to compare how prominent partners were. For example it could be the case that the one case has more prominent partners than the other. Getting an objective measure for how prominent a player is, is difficult, in particular when wanting to compare prominent partners in different markets and technologies.

*Proposition 4a (Burt). Start-ups having networks with many weak ties are better able to access prominent partners.

Proposition 4b (Coleman). Start-ups having networks with many strong ties are better able to access prominent partners.*

Getting access to prominent partners follows a similar logic to getting access to financial resource providers. The effectiveness of network configurations is again heavily dependent on the experience of the entrepreneur when starting and the start-ups development stage. Again you see that the two companies started by inexperienced entrepreneurs (A + C) were dependent on referrals when accessing prominent partners in nine cases. The relations to the people that acted as a referral are labeled as somehow/intimate and the frequency of contact was between 1/week and 1/2 months. Therefore we argue that for start-ups having little business experience strong ties to referral sources are more effective than weak ties in getting access to financial resource providers. So for this group of start-ups proposition 4b seems to be most effective.

For the start-ups that were founded by experienced entrepreneurs weak ties seem to be effective. Because these start-ups have a larger network and legitimacy/status in the market they are better able to access prominent partners directly. Therefore proposition 4a seems to have more relevance for this group of start-ups. Next to experience when starting, stage of development is as well a factor in accessing prominent partners directly. Start-ups like case A have builded a track record and therefore you see that as the legitimacy, status and network grows, directly accessing prominent partners becomes more efficient.

In the following propositions the attention is focused on the role of referrals in financing. Our findings show that referrals are mostly used at start-ups founded by entrepreneurs who have little experience. Because these start-ups (Case A+B) initially
have small networks and lack legitimacy/status in the market they largely depend on their strong ties to provide them access to other actors as explained in the previous propositions. These start-ups see much value in using their partners as an explicit referral source. However, companies founded by more “experienced” people (Case C+D) don’t use their partners as a referral source. However they see much value in using their partners as a more implicit information signal, in particular when it concerns applying for government grants.

In our research model we assumed that referrals of partners are favorable in acquiring financial resources when these partners are prominent. However our findings show that referrals of less prominent partners can be just as effective. Our findings indicate that in case of a stronger tie between referral source and financial resources provider the requirement of a partner being prominent decreases. Therefore we will continue to study the role of referrals in the next propositions not only for prominent partner but as well for referrals of less prominent partners.

Proposition 5a (Burt). Weak ties will be more often explicitly activated as a referral source than strong ties.
Proposition 5b (Coleman). Strong ties will be more often explicitly activated as a referral source than weak ties.

In our cases we identified seven financial decisions in which a referral played a role. When analyzing the referrals sources that helped in getting access to the financial resource providers, we find that in none of the case the intimacy of the contact was scored as “little”. Additionally, the frequency of contact with the referral source was quite frequent with a 1/week or 1/month contact frequency. The length of a relation to a referral source seems to play a minor role. Applying a similar analysis to referrals that played a role in getting access to prominent partners, we find a somewhat similar pattern. In the nine cases in which referrals helped in getting access to prominent partners, in all cases the intimacy of the contact was scored as somehow. Additionally the frequency of contact to these referral sources varied between 1/week and 6/year. Important to note is that in four of these cases the university spin-off centre was involved. It seems to be that at this centre a weaker tie is sufficient in acting as a referral source because this centre is aimed at helping start-ups (frequency of 6/year). Again the length of contact seems to play a minor role. In conclusion it seems to be that referrals are mostly activated when the intimacy of the contact is scored as somehow/very and the frequency of contact is around 1/week or 1/month. Length of relation seems to play a minor role in acting as a referral source. All together we conclude that strong ties are more often explicitly activated as a referral source than weak ties. We continue by discussing the tie strengths that are most effective in a referral.

Proposition 6. A referral will have less impact when the tie between the financial resource provider and start-up is strong

In studying our cases we found seven financial decisions in which a referral played a role. However for the purpose of this proposition I would like to distinguish between two different effects of a referral. The first effect is the connecting function of a referral; the second effect is the influence of a referral on the actual finance decision. These two effects of referrals seem to vary between the different financial resources
providers. The different financial resource providers require different tie strengths before they invest. On the one hand our results show that informal investors and the university only participate when they are relatively strongly connected to a start-up. In the cases where an informal investor or university invested in the company the intimacy of the contact was scored very intimate and the contact frequency was between 1/week or 1/month. On the other hand for a bank or government grant, relatively weaker ties are sufficient. Participation companies and private companies seem to be somewhere in the middle of these two extremes. For the financial resource providers that need a strong tie to the start-up before financing, the connecting function of a referral is most important. However when a weak tie is sufficient for financing, in our cases the decision of a bank to invest in case C and to a minor extend the participation company investing in case B, the effect on the actual decision to invest was bigger. Therefore it seems to be that our cases support proposition 6.

Proposition 7a (Burt). A referral will have more impact when the tie between a start-up and the referral source is weak
Proposition 7b (Coleman). A referral will have more impact when the tie between a start-up and the referral source is strong

In our case studies we identified seven financial events in which a referral played a role. In these events we cannot find a pattern which allows us to conclude that a stronger tie is better than a weak tie to a referral source. Since we found no event in which a weak tie acted as a referral we are not really able to compare these to extremes. However, we had some differences between “strong” and “stronger” ties, however when analyzing this differences we didn’t find differences in effectiveness of referral. Extending the analysis to the referrals that helped in getting connected to prominent partners, we found some support that referrals of contacts that are more frequent are more effective in getting connected to prominent partners. However, we are not able to prefer proposition 7a over 7b or the other way around. Studying more cases or conducting a quantitative study could provide more insight. Table 14 provides an overview of our findings.

CONCLUSIONS/DISCUSSION

Our results show some interesting insights in the optimal positional and relational network configurations for acquiring financial resources. First of all it seems that a network rich in structural holes is favorable for start-up entrepreneurs having various experience levels, knowledge and in different stages of development. Start-ups having networks rich in structural holes tend to have a more diverse finance structure and more prominent partners. We claim that a network rich in structural holes helps a start-up better in identifying the various prominent partners and financial opportunities than a closure network structure.

The optimal relational network characteristics for getting financing are dependent on the experience, knowledge and stage of development of the entrepreneur/start-up. Our results indicate that more experience, more knowledge and a latter stage of
development increase the value of having weak ties. Because these characteristics give the entrepreneur/start-up more status/legitimacy in the market, they can directly access financial resource providers and prominent partners by ties that are initially weak. So for this type of start-up direct network effects seem to play a larger role in getting financed. This does however not imply that they do not profit from having prominent partners in getting financing. Although these entrepreneurs/start-ups don’t use explicit referrals in accessing financing, they acknowledge the value of mentioning a prominent partner in applying for a government grant. However, for start-ups in earlier stages of development having less experience and knowledge strong ties seem to have more value. Because these start-ups lack legitimacy/status in the market, they are more dependent on their strong ties that act as a referral in accessing financial resource providers and prominent partners. In general we found that strong ties are more often activated as a referral source than weak ties. This mechanism seems to be active in particular in accessing financial resource providers that invest under larger uncertainty. So more inexperienced entrepreneurs and new ventures in early stages of their life cycle are more heavily rely on indirect network effects in getting financed.

The conclusions above have large implications for theory. Whereas in literature a structural hole network is often coupled to the effectiveness of weak ties and a closure network coupled to the effectiveness of strong ties, our findings show that positional and relational network characteristics cannot be coupled this simple. Start-ups having little experience and in early stages of development seem to profit from a network rich in structural holes combined with having strong ties, hereby proving the effectiveness of structural holes combined with having strong ties. Next to the implications for general network theory our findings show the value of the 4S model. Some studies study the effect of networks on the acquisition of financial resource without controlling for important variables. Our findings show that next to the social network en economic dimension, we should as well include strategic (legitimacy/status) and cultural (knowledge/experience) factors in order to fully understand the role of network in financing high tech start-ups.

On a more operational level, we tested the value of two theoretical measurement tools for networks. For the positional network identification we included the McEvily and Zaheer (1999) question in our interview. Their tool was very helpful in getting a feel of a start-ups positional network structure. For tie strength we used the three questions of Granovetter (1973) on intimacy, frequency and length of contact. Our case studies however showed that intimacy and frequency had more value in indicating strength of tie and willingness to act as a referral source than length of contact.

An additional interesting finding concerns the effectiveness of referrals and the prominence of the referral source. In shaping our propositions we assumed that a referral of a partner is more effective when this partner is prominent. However our findings show that this is not always the case. Our findings show that the stronger the tie between referral source and financial resource provider, the less important the prominence of the referral is. It seems that when these two actors are strongly tied, the personal trust and commitment between these actors is more important than the prominence of the partner.
Our findings showed that several characteristics of the start-up have a large impact on the effectiveness of certain network configurations. However, our findings show that also the characteristics of the financial resource provider and the prominent partners involved play a role. For example, different financial resource providers require different tie strength for financing. For example, for a bank, a weak tie is sufficient in order to get financing, whereas for an informal investor, a strong tie connection is required before he will provide financial resources to the firm. This has implications for the role that referrals play at different financial resource providers. For financial resource providers where a weak tie is sufficient for financing, the actual impact on the decision is bigger, whereas for financial resource providers that require a strong tie before they finance the connection function of a referral is more important.

Added to this, the type of prominent partner that acts as a (explicit/implicit) referral is as well important in the financing process. Our results show that referrals of business partners are valued over referrals of university partners. The finding that different types of financial resource providers and prominent partners have an effect on optimal network configurations has implication for future research as explained in the next section.

**SHORTCOMINGS/DIRECTIONS FOR FUTURE RESEARCH**

Our case studies provide some interesting insights. However, this paper provides many interesting directions for future research. First, a quantitative study on our research subject could be a good thing in order to statistically back up our findings. In addition, our case studies showed that the effectiveness of certain network configurations is heavily dependent on several key variables. For example, the experience and network an entrepreneur has before starting up his business, the life stage of a company, and the different types of financial resource providers and prominent partners all have implications for the effectiveness of certain network configurations. So by including these factors in a quantitative study could enable us to be very specific on the exact role these factors play in networking for financing.

Another interesting direction for future research is extending the role of networks with simply being connected to a prominent partner without using it as a referral. This case study paper mainly focused on the role of referrals in financing. However, our findings indicate that simply being connected to prominent partners can as well have a strong information effect to financial resource providers. Therefore, future studies should as well focus more on this network mechanism.

Focusing on other resources as well could be an additional direction for future research. Since we focused on the acquisition of financial resources, future research should as well focus on the different network effects as identified in this paper in acquiring for example strategic capital or human capital.

Finally, in this paper we took the perspective of the start-up company. A nice addition would be studying the perspective of the investor as well. Studying this perspective as well would provide more insight in the most effective network configurations from their perspective. For example, it would be possible to study the strength of tie between referral and financial resource provider and its effect on the financing decision. Additionally, when combing this with the result of the study from a start-up
perspective, it would be possible to study all kinds of interaction effects. For example we could study interactions between strengths of ties between start-up and financial resource provider, start-up and referral and financial resource provider and referral source!
REFERENCES


Elfring, T., Scholten, V., Kemp, R., & Omta, O. 2002. *Venturing through...*


Publications.
FIGURE 1

The research model

Start-up company
- Economic capital
- Strategic capital
- Cultural capital

Prominent partner
- Strategic capital
- Economic capital
- Social capital

Financial resource provider
- Cultural capital
- Strategic capital
- Economic capital

Social capital
### TABLE 1

**Data sources**

<table>
<thead>
<tr>
<th></th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
</tr>
</thead>
<tbody>
<tr>
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<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>technostarter</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>x</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
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<td>x</td>
<td>-</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Other online</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- x = Data source available
- - = Data source not available
TABLE 2

Main information sources case A

<table>
<thead>
<tr>
<th>Information source</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Entrepreneur</td>
<td>Very</td>
<td>1/week</td>
<td>6 year</td>
</tr>
<tr>
<td>Informal investor</td>
<td>Very</td>
<td>1/week</td>
<td>5 year</td>
</tr>
<tr>
<td>BD University research institute</td>
<td>Very</td>
<td>1/month</td>
<td>5 year</td>
</tr>
<tr>
<td>Participation company</td>
<td>Somehow</td>
<td>1/month</td>
<td>&gt; 7 year</td>
</tr>
<tr>
<td>Bank</td>
<td>Little</td>
<td>3/year</td>
<td>7 year</td>
</tr>
</tbody>
</table>

TABLE 3

Interconnectiveness information sources case A

<table>
<thead>
<tr>
<th>Information source</th>
<th>Other entrepreneur</th>
<th>Informal investor</th>
<th>BD University research institute</th>
<th>Participation company</th>
<th>Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Entrepreneur</td>
<td>xxxx</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Informal investor</td>
<td>xxxx</td>
<td>xxxx</td>
<td>2</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>BD University research institute</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Participation company</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>3</td>
</tr>
<tr>
<td>Bank</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

XXXX = Not applicable
- = No relation
1-5 = Assessment of the strength of tie by the entrepreneur
### TABLE 4

Main information sources case B

<table>
<thead>
<tr>
<th>Information source</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT</td>
<td>Very</td>
<td>1/week</td>
<td>5-10 year</td>
</tr>
<tr>
<td>Board</td>
<td>Very</td>
<td>1/month</td>
<td>5-20 year</td>
</tr>
<tr>
<td>Shareholders</td>
<td>Somehow</td>
<td>1/month</td>
<td>4-20 year</td>
</tr>
</tbody>
</table>

### TABLE 5

Interconnectiveness information sources case B

<table>
<thead>
<tr>
<th>Information source</th>
<th>MT</th>
<th>Board</th>
<th>Shareholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT</td>
<td>xxxx</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Board</td>
<td>xxxx</td>
<td>xxxx</td>
<td>3</td>
</tr>
<tr>
<td>Shareholders</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

XXXX = Not applicable  
- = No relation  
1-5 = Assessment of the strength of tie by the entrepreneur
### TABLE 6
**Main information sources case C**

<table>
<thead>
<tr>
<th>Information source</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wife</td>
<td>Very</td>
<td>1/week</td>
<td>15 year</td>
</tr>
<tr>
<td>Other Entrepreneur</td>
<td>Very</td>
<td>1/week</td>
<td>2 year</td>
</tr>
<tr>
<td>Other entrepreneur</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
</tr>
</tbody>
</table>

### TABLE 7
**Interconnectiveness information sources case C**

<table>
<thead>
<tr>
<th>Information source</th>
<th>Wife</th>
<th>Other entrepreneur</th>
<th>Other entrepreneur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wife</td>
<td>xxxx</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other entrepreneur</td>
<td>xxxx</td>
<td>xxxx</td>
<td>5</td>
</tr>
<tr>
<td>Other Entrepreneur</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

XXXXX = Not applicable  
- = No relation  
1-5 = Assessment of the strength of tie by the entrepreneur
### TABLE 8

Main information sources case D

<table>
<thead>
<tr>
<th>Information source</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee</td>
<td>Very</td>
<td>1/week</td>
<td>4 year</td>
</tr>
<tr>
<td>University researcher</td>
<td>Very</td>
<td>2/month</td>
<td>10 year</td>
</tr>
<tr>
<td>Manager at other company</td>
<td>Very</td>
<td>1/month</td>
<td>12 year</td>
</tr>
<tr>
<td>Manager at other company</td>
<td>Somehow</td>
<td>1/month</td>
<td>4 year</td>
</tr>
<tr>
<td>Manager at other company</td>
<td>Somehow</td>
<td>1/month</td>
<td>3 year</td>
</tr>
</tbody>
</table>

### TABLE 9

Interconnectiveness information sources case D

<table>
<thead>
<tr>
<th>Information source</th>
<th>Employee</th>
<th>University researcher</th>
<th>Manager at other company</th>
<th>Manager at other company</th>
<th>Manager at other company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee</td>
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<td>5</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>University researcher</td>
<td>xxxx</td>
<td>xxxx</td>
<td>1</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Manager at other company</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Manager at other company</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>-</td>
</tr>
<tr>
<td>Manager at other company</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

XXXX = Not applicable  
- = No relation  
1-5 = Assessment of the strength of tie by the entrepreneur
# TABLE 10

Ties to financial resource providers

<table>
<thead>
<tr>
<th>Company</th>
<th>Finance source</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation (2006)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company A</strong></td>
<td>Informal investor</td>
<td>Very</td>
<td>1/week</td>
<td>5 year</td>
</tr>
<tr>
<td></td>
<td>University</td>
<td>Very</td>
<td>1/month</td>
<td>5 year</td>
</tr>
<tr>
<td></td>
<td>Participation company</td>
<td>Somehow</td>
<td>1/month</td>
<td>&gt; 7 year</td>
</tr>
<tr>
<td></td>
<td>Personal loan</td>
<td>Somehow</td>
<td>3/year</td>
<td>7 year</td>
</tr>
<tr>
<td></td>
<td>Bank</td>
<td>Little</td>
<td>3/year</td>
<td>7 year</td>
</tr>
<tr>
<td></td>
<td>GG</td>
<td>Little</td>
<td>1/year</td>
<td>n.a.</td>
</tr>
<tr>
<td><strong>Company B</strong></td>
<td>Informal investors</td>
<td>Very</td>
<td>1/month</td>
<td>4/5 year</td>
</tr>
<tr>
<td></td>
<td>University</td>
<td>Very</td>
<td>1/week</td>
<td>&gt;10 year</td>
</tr>
<tr>
<td></td>
<td>Other company</td>
<td>Somehow</td>
<td>1/year</td>
<td>10 year</td>
</tr>
<tr>
<td></td>
<td>Participation company</td>
<td>Somehow</td>
<td>3/year</td>
<td>5 year</td>
</tr>
<tr>
<td></td>
<td>GG</td>
<td>Little</td>
<td>3/year</td>
<td>n.a.</td>
</tr>
<tr>
<td><strong>Company C</strong></td>
<td>Other company</td>
<td>Very</td>
<td>1/week</td>
<td>2 year</td>
</tr>
<tr>
<td></td>
<td>Other company</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
</tr>
<tr>
<td></td>
<td>Other company</td>
<td>Somehow</td>
<td>1/month</td>
<td>9 year</td>
</tr>
<tr>
<td></td>
<td>GG</td>
<td>Somehow</td>
<td>1/year</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>Bank</td>
<td>Little</td>
<td>1/month</td>
<td>1 year</td>
</tr>
<tr>
<td><strong>Company D</strong></td>
<td>GG</td>
<td>Somehow</td>
<td>3/year</td>
<td>n.a.</td>
</tr>
</tbody>
</table>
### TABLE 11

**Referrals and getting access to financial resource providers**

<table>
<thead>
<tr>
<th>Company</th>
<th>Finance source</th>
<th>Referral as the source of contact</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation 2006</th>
<th>Importance of referral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company A</strong></td>
<td>Informal investor</td>
<td>Participation company</td>
<td>Somehow</td>
<td>1/month</td>
<td>&gt;7 year</td>
<td>+</td>
</tr>
<tr>
<td>University</td>
<td>BD officers university</td>
<td>Somehow</td>
<td>6/year</td>
<td>7 year</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Participation company</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>Bank</td>
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<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>GG</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>Personal loan</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
</tbody>
</table>

**Company B**

<table>
<thead>
<tr>
<th>Company</th>
<th>Finance source</th>
<th>Referral as the source of contact</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation 2006</th>
<th>Importance of referral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation company</td>
<td>BD officer research institute</td>
<td>Very</td>
<td>1/week</td>
<td>&gt;10 year</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Other company</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>University</td>
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<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>Informal investors</td>
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<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td></td>
</tr>
<tr>
<td>GG</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
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</tbody>
</table>

**Company C**

<table>
<thead>
<tr>
<th>Company</th>
<th>Finance source</th>
<th>Referral as the source of contact</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation 2006</th>
<th>Importance of referral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other company</td>
<td>Business partner</td>
<td>Very</td>
<td>1/week</td>
<td>2 year</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Bank</td>
<td>Business partner</td>
<td>Very</td>
<td>1/week</td>
<td>2 year</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Other company</td>
<td>Business partner</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Other company</td>
<td>Business partner</td>
<td>Somehow</td>
<td>1/month</td>
<td>9 year</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

**Company D**

<table>
<thead>
<tr>
<th>Company</th>
<th>Finance source</th>
<th>Referral as the source of contact</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation 2006</th>
<th>Importance of referral</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>
### TABLE 12

**Ties to prominent partners**

<table>
<thead>
<tr>
<th>Company</th>
<th>Prominent partners</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation 2006</th>
<th>Indirect importance of prominent partner(s) in financing</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Company A</em></td>
<td>Informal investor</td>
<td>Very</td>
<td>1/week</td>
<td>5 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>University research institute</td>
<td>Very</td>
<td>1/month</td>
<td>5 year</td>
<td>+/-</td>
</tr>
<tr>
<td></td>
<td>University professor</td>
<td>Very</td>
<td>3/year</td>
<td>&gt;5 year</td>
<td>+/-</td>
</tr>
<tr>
<td></td>
<td>Business coach</td>
<td>Somehow</td>
<td>1/year</td>
<td>6 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Business coach</td>
<td>Little</td>
<td>1/year</td>
<td>6 year</td>
<td>0</td>
</tr>
<tr>
<td><em>Company B</em></td>
<td>University research institute</td>
<td>Very</td>
<td>1/week</td>
<td>&gt;5 year</td>
<td>+/-</td>
</tr>
<tr>
<td></td>
<td>Large customer</td>
<td>Somehow</td>
<td>1/month</td>
<td>1-5 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(s) *</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alliances **</td>
<td>Somehow</td>
<td>1/month</td>
<td>1-5 year</td>
<td>+</td>
</tr>
<tr>
<td><em>Company C</em></td>
<td>Other Entrepreneur</td>
<td>Very</td>
<td>1/week</td>
<td>2 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Big company</td>
<td>Somehow</td>
<td>1/month</td>
<td>2 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Big company</td>
<td>Somehow</td>
<td>1/month</td>
<td>2 year</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Big company</td>
<td>Somehow</td>
<td>1/month</td>
<td>2 year</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>University research institute</td>
<td>Somehow</td>
<td>2/month</td>
<td>12 year</td>
<td>+/-</td>
</tr>
<tr>
<td></td>
<td>University professor</td>
<td>Somehow</td>
<td>6/year</td>
<td>2 year</td>
<td>+/-</td>
</tr>
<tr>
<td><em>Company D</em></td>
<td>University research institute</td>
<td>Very</td>
<td>1/week</td>
<td>&gt;5 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Big company</td>
<td>Very</td>
<td>1/week</td>
<td>&lt; 2 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Big company</td>
<td>Somehow</td>
<td>1/month</td>
<td>4 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Big company</td>
<td>Somehow</td>
<td>1/month</td>
<td>3 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Scientific institute</td>
<td>Somehow</td>
<td>1/month</td>
<td>&lt; 2 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Big companies**</td>
<td>Somehow</td>
<td>1/month</td>
<td>1-5 year</td>
<td>++</td>
</tr>
</tbody>
</table>

* This is a group of different customers sharing the same network characteristics with respect to the company studied

** This is a group of different alliance partners sharing the same network characteristics with respect to the company studied
# TABLE 13

**Referrals and getting access to prominent partners**

<table>
<thead>
<tr>
<th>Company</th>
<th>Prominent partners</th>
<th>Referral as the source of contact</th>
<th>Intimacy of contact</th>
<th>Frequency</th>
<th>Length of relation 2006</th>
<th>Importance of referral in getting connected</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company A</strong></td>
<td><strong>Informal investor</strong></td>
<td>Participation company</td>
<td>Somehow</td>
<td>1/month</td>
<td>&gt;7 year</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td><strong>Business coach</strong></td>
<td>BD officers university</td>
<td>Somehow</td>
<td>6/year</td>
<td>7 year</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td><strong>Business coach</strong></td>
<td>BD officers university</td>
<td>Somehow</td>
<td>6/year</td>
<td>7 year</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td><strong>University professor</strong></td>
<td>BD officers university</td>
<td>Somehow</td>
<td>6/year</td>
<td>7 year</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td><strong>University research institute</strong></td>
<td>BD officers university</td>
<td>Somehow</td>
<td>6/year</td>
<td>7 year</td>
<td>+</td>
</tr>
<tr>
<td><strong>Company B</strong></td>
<td>**Large customer (s) **</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td>**Alliances **</td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>University research institute</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td><strong>Company C</strong></td>
<td><strong>Big company</strong></td>
<td>Company that invested in C</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>Company that invested in C</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>Company that invested in C</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td><strong>Other Entrepreneur</strong></td>
<td>Company that invested in C</td>
<td>Somehow</td>
<td>1/week</td>
<td>2 year</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td><strong>University research institute</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>University professor</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td><strong>Company D</strong></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>University research institute</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Scientific institute</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td></td>
<td><strong>Big company</strong></td>
<td>No</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>
**TABLE 14**  
**Propositions/Results**

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Burt</th>
<th>Coleman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposition 1a</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 1b</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Proposition 2a</td>
<td>+*</td>
<td>++*</td>
</tr>
<tr>
<td>Proposition 2b</td>
<td>++**</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 3a</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 3b</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Proposition 4a</td>
<td>++*</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 4b</td>
<td>++**</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 5a</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Proposition 5b</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 6</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Proposition 7a</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Proposition 7b</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

* Proposition true for entrepreneurs with extensive experience in the market/technology  
** Proposition true for entrepreneurs lacking extensive experience in the market/technology
APPENDIX

Case description case A

Case A is a company founded in 1999 by two young entrepreneurs with a technology background and little business experience. In the early stage, the company was supported by the university’s business development program. However, after a short while this help was not needed any more. The entrepreneurs quickly developed networking skills and won several prices for innovation and new business. Currently the company has 25 employees.

The positional network could be described as a clique network at start. The network of the company was mainly focused on technology and less on market. However the entrepreneurs were very eager to develop their network. Hereby they were helped by the University’s business development department. After a short while this help wasn’t needed anymore and the entrepreneurs were able to expand their network in multiple directions on their own. Next to their developed network skills, the winning of several prices helped them in getting a status in the market. Therefore accessing new partners themselves became more effective. In the current situation the network could be labeled as a network rich in structural holes.

For financing the company uses a variety of sources. One source (the participation company) had already a weak connection to the company before starting. The bank, Government Grants and a personal loan were accessed by the entrepreneurs themselves. The university and the informal investor were connected through mediate/strong tie referrals. In the current situation the company goes for financing information to the informal investor, the participation company and the bank. When asking the company about its most prominent partners a variety of partners came up. The prominent partners explicitly mentioned were all accessed through mediate/strong tie referrals.
Case description case B

Case B is a company founded in 2001 by an entrepreneur with over 20 years of technology and business experience. Before starting the entrepreneur had already a large network in the relevant market. His network and reputation had a large impact on the development of his company. Currently the company has about 20 employees.

In theoretical terms the positional network of case B can be described as a structural hole network from start. Because of his experience and reputation the entrepreneur is able to directly connect to new partners without help from referral sources. The entrepreneur was and is very active in visiting conferences and trade shows. The entrepreneur sees this as an intentional strategy to enhance the chance of getting new contacts. Meeting a new partner is often described as coincidence; however the entrepreneur claims that you can manipulate the factors that enhance “coincidence”.

For accessing financial resources the company was not dependent on referrals. The company has five types of different financial sources. The other company that invested in B and the University were already connected to the entrepreneur before starting. The government grants and informal investor were accessed by the entrepreneur himself without help from a referral. Only in accessing the participation company, the company had some help from a (strongly tied) research institute business developer. The entrepreneur doesn’t consult external information sources for financing because he claims that all financial expertise is present in the company. The company has a wide variety of prominent partners, all accessed without help of explicit referrals.
Case description case C

In 2004 Case C was founded as a spin-off of three companies. The owner had little business experiences and a moderate technology background. For its development, the company heavily relied and still relies on the parent companies. Currently the company has three employees.

The network of can be described as a closure network when starting. The company is a spin-off of three companies and is still heavily dependent on these companies in developing its networks. In contrast to case B, the entrepreneur of company C states that he doesn’t visit many conferences and trade shows since it takes a lot of time. Although the size of the network has grown over time, the network of C can still be labeled as a closure network, since the network is still very redundant.

In accessing financial resource providers, the network is/was very dependent on referrals. Only for Government Grants, referrals didn’t play a role. However for the three other companies and the bank, referrals of mediate/strong ties played a very important role. In getting connected to prominent partners, a similar pattern can be identified. In particular for prominent market partners, strong ties were an important referral source.
Case description case D

Case D is founded in 2004 by an entrepreneur with moderate business and extensive technology experience. The entrepreneur had a large network at start and had much experience in applying for government grants. Therefore the entrepreneur was able to finance his company solely on private investments and government grants. Currently the company has 2 employees.

Similar to case B, the network of D can be described as rich in structural holes from start. The entrepreneur has extensive experience in working for a university. In working for the university he was responsible for writing and executing many project proposals. In doing this work he gathered extensive contacts within universities and business, because getting funding is often dependent on having a variety of partners cooperating in the project. When starting the business the entrepreneur uses the network he developed when working for the university. Added to this the name and status he gained in doing this work helps him in getting direct access to new partners.

The financing of company D is quite a rare case. Because the entrepreneur had much experience in applying for Government Grants, he is able to fully finance his company by Government Grants (next to a personal investment). The entrepreneur doesn’t consult external information sources for financing, because the company has the knowledge of applying for Government Grants within the company and has no additional need for money. The prominent partners of the company as mentioned in the interview, were all accessed directly without using a referral.

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1 At the University of Twente there is a support program for entrepreneurial start-ups. When supporting the start-ups a file is kept on the development of the company containing several versions of business plans and notes of meetings with the support coaches. More information on the TOP program can be found at www.utwente.nl/top
The relation between key events in the development phase and the financial structure of NTBFs in the software sector

Running title: The relation between key events and financial structure in NTBFs

Teresa Hogan*
Dublin City University Business School
Glasnevin, Dublin 9,
Ireland.
E-mail: teresa.hogan@dcu.ie

and

Elaine Hutson
UCD Michael Smurfit School of Business
Blackrock, Co. Dublin, Ireland
The relation between key events in the development phase and the financial structure of NTBFs in the software sector

Abstract

This paper finds no systematic relation between product lead time and acquisition of first external funds in new technology-based firms (NTBFs) in the software product sector. Contrary to the stage model’s predictions, these firms are just as likely to secure finance in advance of producing their first product beta as they are to receive funds subsequently. Product lead times in this sector are short. Firms produced their first product beta in a median of 12 months and acquire their first external funds a median 3 months later. The timing of these two events, however, is not significantly different. There is a significant difference in the mean time to receipt of consulting revenues and the development of first beta, suggesting that most software product companies use consulting revenues to fund product development

Keywords: Stage model, capital structure, product lead time, NTBF, soft starts.
It is widely agreed that technology-based small and medium-sized enterprises (SMEs) play an important role in the development and diffusion of innovation, and economic growth and employment. As a result, the financing of technology-based firms has become an increasingly important focus of government policy in the European Union. At the centre of concern is the possibility that new technology-based firms (NTBFs) experience severe financing constraints, especially at start-up.

We examine this issue through the lens of the stage model (or life cycle model), which has been the dominant theoretical framework in empirical research on NTBFs. One of the major criticisms of the stage model as applied to NTBFs is that they are not a homogenous group. Several scholars have suggested that in order to provide a framework for more meaningful analysis of the development and growth of firms, the stage model must be tested on specific sectors. We take up this suggestion by looking at the software product sector. In this paper we use data gathered via a large-scale survey to examine the financing of 117 privately held firms in the Irish software sector.

While several studies have tested the general model of the life cycle of technology-based firms (Arbaugh and Sexton, 1993; Hansen and Bird, 1997; Kazanjian and Drazin, 1990), few have tested the stage model in relation to financing events. We examine the timing of key milestones in the start-up phase of the sample firms in relation to the timing of the first injection of external finance. The key milestones include the first product beta, recruitment of first employee or employees, and receipt of first product revenue. We also test Bullock’s (1983) hypothesis that technology firms may be ‘soft starts’ by
examining the extent to which software product firms rely on consulting revenues.

We show that, in contrast to firms in other high technology sectors that face long product lead times and high capital costs, product lead times in the software sector are short (a median of 12 months to the first product beta). Sample firms acquire their first external funds a median 3 months later, although the timing of these two events is not significantly different. In fact, only slightly more than a third of sample firms receive their first external funding before producing their first product beta. As well as short product lead times, the absence of external funding at start-up can be explained by the critical role played by consulting revenues in the financing of the sample firms. Software firms are indeed ‘soft starts’: we find that the receipt of consulting revenues is the earliest activity recorded by the sample firms – a median of 3 months after formation. The combination of short product lead times and the availability of consulting revenues appear to give software firms considerable flexibility in their choice of financing.

The reminder of the paper is structured as follows. The next section presents an overview of the software sector in Ireland. This is followed by a discussion of the literature on NTBFs and the stage model, and includes the paper’s hypotheses. In the fourth section, we discuss the survey methodology and presents summary data on the characteristics of the sample. Our findings are discussed in three sections: capital structure by stage, key events in the formation process, and sequencing of the key events. The final section concludes.
THE SOFTWARE SECTOR IN IRELAND

The software sector is sub-divided into ‘products’ and ‘services’. The term software products refers to packaged software, defined ‘as commercially available programmes for sale or lease from systems vendors and independent software vendors’ (IDC, 2000: 189). Software products are generally produced in large volumes for mass markets, while bespoke software is usually provided on a client-by-client basis. Software services usually refers to bespoke software, and the term includes consulting, implementation, support services, operations management and training (IDC, 2000). We define software product firms as those that are primarily involved in the development and commercialisation of their own products; that is, they have developed or were in the process of developing software packages for commercialisation.

The software sector is an important component of Ireland’s economic output. In 2000 Ireland and the United States together accounted for more than 55 percent of OECD software exports. Ireland has become the centre of European manufacturing and distribution for many of the world’s top software firms, accounting for over 40 percent of all packaged software and 60 percent of all business software sold in Europe (Enterprise Ireland, 2000). It is also the world’s largest exporter of software services. Software services exports of $5.48 billion in 2000 comprised one-third of Ireland’s total services exports. Multinationals account for most of the activity in the Irish software sector. This paper, however, is concerned with the indigenous software cluster, which accounts for about 10 percent of the sector’s output.
THE STAGE MODEL AND NEW TECHNOLOGY-BASED FIRMS

The stage model paradigm has long been popular in both the practical and theoretical literature on organisational evolution. The model portrays the development of new firms as linear and sequential, consisting of identifiable stages. Its underlying premise is that the firm requires different management and structures in order to respond to the unique challenges posed by the various stages in the firm’s evolution. Acceptance of the model in the technology sector is demonstrated by the structuring of venture capital deals into stages or rounds. Nesheim’s (2000) widely acclaimed handbook *High-Tech Start Up* breaks down the capital formation process into 14 stages, from the idea phase through to initial public offering (IPO).

The stage model has been used extensively in academic analysis of technology-based start-ups (see, for example, Galbraith, 1982; Hansen and Bird, 1997; Kazanjian, 1988; Kazanjian and Drazin, 1990; Roure and Keeley, 1990). Despite its popularity as a theoretical framework, the stage model as applied to the NTBF has received little empirical validation. The research that has been conducted confirms the hypothesis of Reynolds and Miller (1992) that, rather than occurring sequentially as predicted by the life cycle model, key events (such as first employee hire and first sale) can occur concurrently or in any order in the general population of start-ups. Hansen and Bird (1997), for example, analyse key events to test the validity of the stage model in NTBFs. They suggest that firms are likely to hire their first employee before or during the product development stage. Because development and testing precedes the first sale, the first employee hiring should also precede the first sale. They found, however, that while some of their sample firms followed this sequence as predicted by the stage model, others did not.
While many prior studies of NTBF development have disregarded financing issues, more recent research holds that stages in the firm’s development are paralleled by changes in its financial structure and access to finance. In a large-scale study of high-technology firms, Roberts (1991) points out that

The new technology-based firm evolves through a succession of several stages of corporate growth and parallel development in its finance. The time during which a company can be classified in a particular phase varies widely among firms and the dividing line between phases is at best fuzzy. Yet the relative stage of evolution does strongly influence the type and amount both of capital required and especially of capital available (Roberts, 1991: 125).

Roberts (1991) identifies four stages in the financial lifecycle of NTBFs: seed, start-up, early growth, and sustained growth. These are presented in Table 1, which includes the primary sources of financing available and the potential financial problems encountered at each stage.

Insert Table 1 about here.

**The Seed Stage**

As noted in Kazanjian (1988) and Kazanjian and Drazin (1990), NTBFs differ from the general population of start-ups in that they are characterised by an intensive period of research and development, which, if successful, results in the development of a real asset that is as yet unproven in the marketplace. At this seed (or zero) stage, the organisation tends to be informally structured and much of the initial research and development may be undertaken on a part-time basis while the founder is still based at a university, research laboratory or commercial organisation. The success of this phase is highly dependent on the human capital
of the founder and is characterised by high levels of uncertainty. In order to
develop the product, the founder commits limited personal funds, assumes the
risk of failure, and puts in time and effort (so called ‘sweat equity’). This phase is
funded primarily by the founder’s personal savings and those of friends and
family.

**The Start-Up Stage**

The seed stage is followed by prototype development and testing at *start-up*. It
is likely that the founders’ personal funds will be exhausted during this stage, and
some source of outside funding is usually necessary. This is because the NTBFs
tend to be characterised by long product lead times. However, amongst NTBFs
there will be great variation in capital requirements and product lead times.
Oakey (1995) highlights the financial implications of differences in the innovation
cycle of NTBFs in different sectors such as software vis á vis biotechnology or
electronics. Software firms clearly require less initial funding because product
lead times for software products are generally short, and early costs are usually
smaller, involving mainly human rather than expensive physical capital (Roberts,

There is limited evidence on NTBF financing at start-up. It is likely, however, that
external sources play a minor role in NTBFs at start-up, and this may be due to
financing constraints. Roberts (1991) reports that:

> Initial capital is supplied most frequently by entrepreneurs themselves from their own savings, second by their family and friends, and third by private investors, all these being sources of capital outside of the normal channels (Roberts, 1991:141).
In the UK, Moore (1994) reports that NTBFs raised only 7 percent of initial funding from banks, compared with 24 percent for SMEs in general, suggesting that NTBFs face greater problems in debt markets than their counterparts in other sectors at start-up. If private equity and/or venture capital are unavailable, the NTBF is likely to face serious financial constraints. Undercapitalisation at start-up has been linked to poor growth performance (Lumme, Kauranen, and Autio 1994; Moore, 1994).

As an alternative source of finance, high-technology firms may rely on cash flows from consulting activities. Bullock (1983) suggests that many begin life as ‘soft starts’; founders can choose a low-risk service-orientated ‘soft’ start-up entry strategy and ‘harden’ over time to become product-orientated ventures. PricewaterhouseCoopers (1999) demonstrates that Bullock’s (1983) ‘soft start’ description is particularly apt for the software sector; many software product companies start out providing bespoke development and consulting services to businesses before going on to develop software products.

**The Early Growth and Sustained Growth Stages**

The ‘early growth’ stage marks the end of product development, and at this stage the firm begins to establish a foothold in the market. The risk of failure recedes as sales revenues increase and retained profits become an increasingly important source of finance. By the time the NTBF reaches the ‘sustained growth stage’ it will have diversified in terms of products and markets. The firm’s investment decisions and financing requirements will not differ substantially from those of other successful large companies.
**Critiques of the Stage Model**

While Roberts’ model is potentially useful for explaining NTBF financing, the well-known criticisms of the stage model apply. The model implicitly assumes that all firms pass uniformly through these predetermined stages (Gibb and Davies, 1991; O’Farrell and Hitchens, 1987). Many firms do not survive beyond the first stage, and few of the survivors achieve the sustained growth phase. In relation to sequencing of the stages, Storey (1994) questions the validity of the assumption that the movement from one stage to another is driven by the emergence of problems or crises. Other researchers view new firm development as a stochastic rather than as a linear sequence as the stage model implies (Gersick, 1994; Katz, 1993; Reynolds and Miller, 1992). In a rare empirical test of the stage model for SMEs, Reynolds and Miller (1992) examined the sequencing of four events: principals’ commitment, first hire, first financing, and first sales. They found little support for a linear and sequential formation process.

**Hypotheses**

The stage model predicts that NTBFs are primarily self-financing at the start-up phase in their evolution. Product lead times, however, may affect the firm’s ability to finance this phase internally. The longer the product lead time, the more likely firms will require external financing (Oakey, 1995; Roberts, 1991). In the software sector, product lead times are generally shorter than in other high technology sectors, and capital requirements are relatively low (Oakey, 1995). This suggests that the software product firm may be able to produce its first product beta without having to first secure external funds. The central hypothesis of this paper is that software product firms will be primarily self-financing at start-up.
H1: Beta development will precede the first injection of external funds in software product firms.

Bullock (1983) suggests that NTBFs, particularly in the software sector, are ‘soft starts’ that engage in consulting activities and evolve over time to become product companies. Bullock notes that the ‘soft start’ is particularly applicable to the software industry because the advent of low-cost computing has greatly extended the range and complexity of the consultancy services that new firms in the sector can offer. Low-cost computing has blurred the soft/service - hard/manufacturing distinction that was common in earlier years and has allowed the steady growth of hard service companies, such as software houses (Bullock, 1983: 17).

Hypothesis 2 posits that software product firms use consulting revenues to finance the product development phase; that is, that they engage in consulting activities prior to beta development.

H2: Software product firms are ‘soft starts,’ and engage in consulting activities prior to producing their first product betas.

Software development is heavily dependent on human capital input, and capital costs are relatively low. According to the stage model for the technology sector, firms are likely to hire their first employee(s) before or during product development and testing, so that the first hire precedes the first sale (Hansen and Bird, 1993). This gives rises to hypothesis 3:
**H3:** First hire will precede first beta in software product firms.

**SAMPLE, SURVEY AND DATA**

NTBFs are a sub-class of high technology firms. Little’s (1977) definition of NTBFs is widely accepted: they are less than 25 years old, their product or service must be based on the exploitation of an invention or technological innovation, and they must be independent. Little’s (1977) intention was to exclude large and/or well-established high-technology firms, so that NTBFs can be viewed as a distinct sub-sector of high technology firms. However, as pointed out by Storey and Tether (1998: 934), “in some instances it is unclear whether the word ‘new’ applies to the firm or to the technology or both.” In a recent review, the term ‘technology-based new firm’ (TBNF) was adopted, perhaps in an attempt to clarify this point (Autio, 2000). In this study, the word ‘new’ refers to both technology intensity and firm age; our software firms are less than 25 years old. In terms of firm size and legal status, consistent with the EU SME definition, we include firms that have less than 250 employees and are legally independent, insofar as they are not subsidiaries of multinational firms.

The population of independent Irish software product firms was identified using a wide variety of information sources, including lists provided by the Irish Software Association and the National Informatics Directorate, lists of occupants of innovation parks, lists of participants in a national technology entrepreneurship award program, and firms cited in specialist journals. At the end of 2001 the population of independent software product SMEs in Ireland was 257.

The survey design is based on self-administered questionnaires using the tailored design method (Dillman, 1976 and 2000). The survey was administered by mail
and addressed to named CEOs. A covering letter requested that the surveys be completed by the founder, or by the lead founder if the company had been founded by a team. Respondents were given the choice of completing either a paper or web-based questionnaire. The first follow-up contact was also by mail, and the second by telephone. The final contact was via e-mail, and it contained a hyperlink to the electronic version of the questionnaire. Completed questionnaires were received during April and May 2002. The number of valid returns was 117 out of a population of 257, giving a response rate of just under 46 percent. This is a robust response rate relative to SME survey response rates in general, as reported by Curran and Blackburn (2001).

Table 2 summarises the data on firm age (Panels A and B) and size by number of employees (Panel C). Panel A shows that the youngest firm is 5 months old and the oldest is 27 years. Two firms are more than 25 years old, and thus they fall beyond Little’s (1977) age criterion. However, as they fulfilled all of Little’s other criteria we have decided to include them.

The under-representation of the smallest and youngest firms is a key issue in small business research. Overall, young firms are well represented in our sample. The average firm is just under 6 years (5 years and 10 months), and the median age is 4¼ years. Panel B of Table 2 delineates the sample into 4 age categories. Experts in the Irish software sector estimate that approximately 30 start-ups were formed in this sector in 2001 (HotOrigins, 2002). Fifteen of our sample firms are less than 2 years old, indicating that new firms are well represented.

Insert Table 2 here
Panel C of Table 2 shows the size distribution for the dataset of 115 firms using the European Union classification system for SMEs. In 2002, the sample firms employed a total of 3,005 people, giving an average of 26 employees per firm. Micro and small firms are well represented: 37 percent of firms had less than 10 employees, 48 percent had between 10 and 49 employees and 5 percent had between 100 and 249 employees.

Table 3 presents the data on start-up costs. The vast majority – 59 percent – had very small start-up costs with less than €127,000 in capital. A small proportion (almost 10 percent) started with very large investments of over €1,270,000.

The survey also requested details of financing sources, separated into internal (savings, consulting revenues and retained earnings) versus external (bank debt, venture capital, private investors and government grants). Respondents were asked to identify their firm’s formation date and to supply dates for key events in the formation process relative to the formation date. These events are development of the first product beta, recruitment of the first employee(s), receipt of the first revenues from consulting activities and receipt of the first revenues from product sales, and first external funding. To enable greater precision than in prior studies that have used annual data, we requested this information to the nearest month.

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1 Start-up cost figures were requested in Irish punts because the questionnaire was sent out just after the full introduction of the Euro in early 2002. The figures have been converted into euro at the €/£ exchange rate of 1.27.
THE CAPITAL STRUCTURE OF SOFTWARE PRODUCT FIRMS BY STAGE

The stages are defined as follows: start-up (less than 2 years), commercialisation (2-4 years), growth (5-9 years) and maturity (more than 10 years). The time bands for the start-up, commercialisation and growth stages for software product firms are based on estimates provided the National Software Directorate (1997), and the description of the four stages is based on Roberts (1991), with one exception – Roberts (1991) does not include a mature stage in his model. The description of the mature phase comes from traditional financing stage models as outlined by Weston and Brigham (1970) and the time band is taken from Berger and Udell (1998).

Table 4 provides summary capital structure information at each stage for the 96 firms in the sample that provided detailed funding information. The average figures for the full sample show a 50/50 divide between internal and external sources of finance. A mere 4 percent of financing is provided by banks, and the remaining outside finance (46 percent of the total financing requirement) is private equity and government grants. An important and novel finding is that the largest individual source of internal finance for the firms overall is consulting revenues, providing almost 20 percent of total financing. This is closely followed by retained profits (17 percent) and savings (14 percent). These findings are largely consistent with prior research on capital structure in NTBFs. In the US, Roberts (1991) found that bank finance did not feature at all as a funding source for high-technology start-ups, and private outside equity comprised 21 percent of total funding. However, the proportion of private equity in Irish software firms, at 39 percent, is much higher than for UK-based NTBFs reported by Moore (1994), who found that venture capitalists provide only 10 percent of funding.
Financing clearly differs depending on the firm’s age. External sources are more important for firms aged 2 to 10 years, and are less in evidence for firms 10 years old or more, for which retained earnings comprises almost half of financing requirements (46 percent) as reliance on outside finance declines to only one-quarter of the total. Consistent with hypothesis 1, it is clear that the NTBFs in our sample are primarily self-financing at start-up. Assuming ‘start-up’ is defined as firms less than two years old,² 73 percent of financing for the 12 firms aged less than 2 years is sourced internally. Most of this funding is from personal savings of the founders (43 percent), and a substantial component is provided by cash flows from consulting services (27 percent of total funding). This is consistent with hypothesis 2 and Bullock (1983) that software product companies are ‘soft starts’ and rely in their early years on revenues from consulting activities.

External funding is at its highest for firms at the commercialisation stage of their evolution – those between 2 and 4 years old. Sixty-eight percent of finance is sourced externally, largely from venture capitalists (38 percent) and private investors (18.5 percent). The reduction in internal sources and the increasing reliance on external sources during the commercialisation is consistent with the stage model; as savings have been run down and sales have not yet taken off (and firms have therefore not yet had the opportunity to build up retained profits), funds for commercialisation expenses must be sourced from outside the firm. Another interesting feature of firms at the commercialisation stage is that funds from consulting revenues are at their lowest (13.5 percent of total funding).

² Several studies have defined ‘start-up’ in this way, the most recent being Cassar (2004).
This would probably be because the firm’s human resources are mobilised into the commercialisation effort, and consulting activities must therefore be curtailed.

**KEY EVENTS IN THE FORMATION PROCESS**

Table 5 reports the timing of the following key events in the start-up process of software product firms: development of first product beta, recruitment of the first employee(s), receipt of the first revenues from consulting activities, receipt of the first revenues from product sales, and first external funding. The timing is calculated from the month of formation. Column 6 reports the number of firms that attained the five milestones described above, and column 7 is the number of firms that had not reached the particular milestone. There are considerable differences in the proportion of firms reporting attainment across the five events. At the time of the survey, all but four firms for which data are available had recruited their first employee, and all but six had produced their first product beta. The number of firms reporting attainment for the remaining three events is much lower. Twenty-three firms (or 19.7 percent) had not received their first consulting revenues; 18 (15.3 percent) had not received revenue from product sales, and 24 (20.5 percent) had not acquired external funding.

Insert Table 5 about here.

The mean and median number of months from start-up to the attainment of each milestone appear in columns [1] and [2] of Table 5. All of the means exceed the medians, indicating right-skewness in the data. This is confirmed by the

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3 One extreme score, relating to time to first beta, was removed from the analysis. This company was formed in 1975 but did not produce its first beta until 1999 and provided no information on other founding events.
histograms of the time to milestones in Figure 1. The discussion of the summary statistics will therefore concentrate on medians rather than means, and the statistical testing will be non-parametric.

The median time to first product beta was 12 months, which was well after the firms hired their first employee (4 months), and earned their first consulting revenues (3 months). First product revenues were earned a median of two months after product beta in month 14, and first external funding was obtained one month later – a median of 15 months after start-up.

Figure 1 shows considerable variation in the distribution of these milestones over the sample firms. Most firms achieved all five milestones during the first year of operation. Eighty-eight firms (76 percent) had hired at least one employee by the end of their first year, and 31 (27 percent) had employed staff immediately on or before the formation date. A substantial proportion (66 percent) had received their first consulting revenues during the initial 12 months of operation, and 19 had received these revenues before or at the time of start-up. Smaller counts are recorded during the first year for first product revenue and first external financing (36 percent for each), and 58 firms (50 percent) produced their first product beta during their first year of operation.

Insert Figure 1 about here.

**SEQUENCING OF THE KEY EVENTS**

The test statistics for the sequencing of the key events are presented in Table 6. As the data are not normally distributed, the Wilcoxon rank sum test is used to test for timing differences. In addition to reporting results on tests for
Hypotheses H1, H2 and H3, the table reports the findings for one other sequence: beta versus product revenues. As product revenues can be generated only after the first product beta is available, this comparison is included as a check on the consistency of the survey responses.

Insert Table 6 about here.

**H1: Beta Before External Funding**

Hypothesis H1 suggests that software product firms should be able to produce their product betas without needing to access external finance. At first glance, the findings in Table 5 tend to support hypothesis H1, as the sample firms produced their first product beta a median of 12 months after formation and they received their first external funding three months later. The histograms in Figure 1, however, show that the distribution patterns for the two milestones are very similar, and the Wilcoxon test reported in Table 6 confirms that the times taken to reach these two milestones are not significantly different ($p = 0.44$). H1 therefore is not supported by the data.

Table 7 presents more detail on the sequencing of these two important events. Monthly observations were available for both events for 92 firms. Annual data for 17 firms was included, because in these cases the reported milestones occurred in different years. The table shows that the sample software product firms were just as likely to secure finance in advance of producing their first beta as they were to receive funds subsequently. Thirty-six percent of firms produced their first product betas before receiving funding (row [B]) and 37 percent received funding in advance (row [C]). Four firms secured funding and produced their first betas concurrently (row [A]).
Table 7 also reports the findings for 27 firms that did not attain one or both of these events. For the 20 firms that had produced a product beta but had not received external funding (row [D]), it is possible that they intend to seek external funding in the future. However, it is also possible that these firms intend to remain entirely self-funded. An examination of the age structure of this group reveals that four are less than two years old, six are between two and four years, and 11 are more than five years old. The ‘less than two years old’ group may well intend to seek external funding in the future, but this is a less plausible explanation for the absence of external funding amongst the older firms. All but four of the 11 firms in the ‘more than five years old’ age group had produced their first product beta within two years of formation, and all but one had produced their first product beta within three years. It is therefore likely that this group of mature firms demonstrate a different pattern to the general population of software firms, in that they would appear to eschew outside funding, preferring to finance their development from internal sources.

Three firms had received funding but had yet to produce their first product beta (row [E] of Table 7). These firms could probably be categorised as having received funding prior to producing their first beta, unless of course the product development phase proves fruitless. Finally, three firms had neither secured external funding nor produced their product betas (row [F]).

**H2: Consulting Revenues Before Beta**

Hypothesis H2 posits that ‘soft start’ implies that firms would undertake consulting activities before their first product betas are available. Table 5 shows
that the receipt of consulting revenues is the earliest activity recorded by software firms, occurring a median three months after formation. Only 23 firms report receiving no consulting revenues. In contrast, the median time to first product beta is 12 months. The Wilcoxon test (Table 6) confirms that consulting revenues are obtained before first product beta (p = .00). This result strongly supports H2 - that software product firms begin life as ‘soft starts,’ supporting Bullock’s (1983) model of the evolution of NTBFs.

**H3: First Hire before Product Beta**

Hypothesis H3 posits that the first hire will precede the development of first product beta. Table 5 shows that sample firms hired their first employee(s) a median of four months after formation, with first product beta 8 months later. The Wilcoxon test presented in Table 6 confirms that employees are hired significantly earlier than the appearance of the first product beta (p = .00).

Along with consulting activities, hiring employees is one of the earliest events in the life of Irish software product firms. Although the median time to first hire is one month later than the median time to first consulting revenues, a Wilcoxon test shows that the difference in the timing of these two events is not significant (p = 0.94). This finding is not surprising because these two events would be highly interconnected. As firms increase their consulting activities, revenues increase, facilitating the hiring of additional staff. Equally, the hiring of staff increases the pressure on firms to generate income to cover salary costs, which in turn drives the pursuit of consulting contracts.
Product Revenues Versus Beta: A Consistency Check

Table 5 shows that first product revenues (median 14 months after formation) follow hard on the heals of the first product beta (12 months), as would be expected. Despite these events occurring so close to each other, the last row of Table 6 reports that the timing of first product beta significantly precedes first product revenues. Figure 2 shows the number of companies reporting both first product beta and first product revenues, cumulated by months. Fifty-eight firms had produced a product beta and 42 had earned product revenues within in the first year after they started, and most had achieved both objectives by year 5. The two lines on Figure 2 remain approximately equidistant, which is indicative of consistency in the survey responses.

CONCLUSION

The financing of NTBFs continues to be an important issue for both practitioners and academics, and the stage model remains a central framework of analysis. In this study, we presented a model of financing in software product firms that provides a snapshot of financing at 4 different stages: start-up (less than 2 years), commercialisation (2 - 4 years), growth (5 - 9 years) and maturity (more than 10 years). The analysis revealed significant differences in the sources of funding used by firms at each stage, providing strong support for the stage model. In common with other NTBFs and SMEs in general, financing at start-up and at maturity in software product firms is dominated by internal sources, which account for on average 72.5 percent of funds used by start-ups and 76 percent of funds employed by mature firms.
To test the applicability of the stage model in software product firms specifically, we sought to determine how key developments in their start-up stage are linked to financing. This analysis revealed a number of particularly interesting findings.

First, the evidence suggests that while software product firms produce their first product betas prior to securing their first external funds, the difference in the timing of these two events is not significant statistically. In addition, the analysis of their sequencing demonstrates that firms are just as likely to receive external funding before producing their first betas as they are to receive funding subsequently. Consistent with prior research that has questioned the stage model’s implication that there is a uniform pattern of start-up in SMEs general (Reynolds and Miller, 1992), our disaggregate analysis reveals that there is no uniform pattern that drives funding at start-up. This weakness in the stage model is often ignored by both academics and practitioners. Few would deny the utility of a framework that identifies the typical stages in a process, but in reality not all firms pass uniformly through these predetermined stages. Our research indicates that even within a specific sector there will be different start-up configurations. In addition, external conditions such as the availability and cost of funding will also have an impact on the process. In particular, the supply of early stage venture capital to NTBFs is highly susceptible to changes in market conditions.

Second, product lead-times are short in the software product sector. It takes software product firms only 12 months to develop their first product beta. This contrasts with product lead times of up to 5 years in biotechnology and pharmaceutical NTBFs (Oakey, 1995). Since they are shorter, lead-times do not appear to dictate financing at start-up in the software sector. The implication for
researchers is that there are dangers in treating NTBFs as a homogenous group. Our analysis has shown the potential to augment the explanatory power of the stage model by 'grounding' it in a sector-specific analysis rather than relying on generalisations for the entire population of NTBFs.

Future research might involve a disaggregate analysis of stages other than the start-up phase. The commercialisation stage, for example, is of particular interest because it is unique to NTBFs; SMEs in general serve established markets. We have shown that software firms are particularly reliant on external funds during the commercialisation stage. A disaggregate analysis could attempt to identify the key drivers of the funding requirement during commercialisation of NTBFs in different sectors, which would assist in an understanding of whether and to what extent firms might be financially constrained at this critical time in their evolution. Obviously, the analysis would be bound by the external environment of the day, and in particular conditions in technology and financial markets. However, such an analysis might provide more relevant guidelines to practitioners than those proposed by the general model, once it is recognised that observed practices and strategies may have a limited shelf life.

A third important finding is that software product firms make extensive use of consulting activities as a source of finance. The vast majority of our sample software product firms are 'soft starts', in that they undertake consulting activities to finance product development. The receipt of consulting revenues is on average the first activity recorded by software firms, and only 23 firms in the sample received no revenues from consulting activities. This is good news for potential future software entrepreneurs. The ability to conduct consulting activities clearly gives software firms considerable financial flexibility in their early
years. It also suggests that as founders can substitute human capital for financial capital, team-based start-ups might be a good strategic choice.
REFERENCES


Table 1. The financial life cycle of the new technology-based firm

<table>
<thead>
<tr>
<th>Stage</th>
<th>Source of finance</th>
<th>Potential problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seed</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Concentrated R&amp;D resulting in product idea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• First test for commercial viability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Undercapitalisation</td>
</tr>
<tr>
<td></td>
<td>• 3Fs: Founders, Family and Friends</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Research Grants/Equity</td>
<td></td>
</tr>
<tr>
<td><strong>Start-up</strong></td>
<td>As above plus:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prototype development design and redesign</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Targeting reference customers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• overdrafts, bank loans</td>
<td>• Undercapitalisation</td>
</tr>
<tr>
<td></td>
<td>• leasing</td>
<td>• Finance gap</td>
</tr>
<tr>
<td></td>
<td>• private investors</td>
<td>• Loss of control</td>
</tr>
<tr>
<td></td>
<td>• venture capital</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• seed funds</td>
<td></td>
</tr>
<tr>
<td><strong>Early Growth</strong></td>
<td>As above plus:</td>
<td>As above plus:</td>
</tr>
<tr>
<td></td>
<td>• foothold in the market</td>
<td>• Maintaining ROI</td>
</tr>
<tr>
<td></td>
<td>• sales growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• move towards profitability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• large commercialisation costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• retained profits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• trade credit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• longer-term finance from financial institutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• supplier/buyers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• new market issue</td>
<td></td>
</tr>
<tr>
<td><strong>Sustained Growth</strong></td>
<td>As above</td>
<td>Maintaining ROI</td>
</tr>
</tbody>
</table>

**Notes.** This table is derived from Roberts (1991). In addition, potential problems encountered at each stage are flagged.
Table 2. Age and size distribution of the sample firms

Panel A: average age (months)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70</td>
<td>51</td>
<td>5</td>
<td>324</td>
</tr>
</tbody>
</table>

Panel B: number of firms by age

<table>
<thead>
<tr>
<th>Years</th>
<th>Number of firms</th>
<th>Proportion of sample (%)</th>
<th>Proportion of sample cumulative (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td>15</td>
<td>12.8</td>
<td>12.8</td>
</tr>
<tr>
<td>2 – 5</td>
<td>54</td>
<td>46.2</td>
<td>59.0</td>
</tr>
<tr>
<td>6 - 10</td>
<td>26</td>
<td>22.2</td>
<td>81.2</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>22</td>
<td>18.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Panel C: number of firms by size of workforce

<table>
<thead>
<tr>
<th>Size class</th>
<th>Employees</th>
<th>Number of firms</th>
<th>Proportion of sample (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro</td>
<td>0</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1 - 9</td>
<td>38</td>
<td>33</td>
</tr>
<tr>
<td>Small</td>
<td>10 - 49</td>
<td>55</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>50 - 99</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Medium</td>
<td>100 – 249</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>&lt; €63,500</td>
<td>53</td>
<td>46.1</td>
<td>46.1</td>
</tr>
<tr>
<td>€63,500 – €126,999</td>
<td>15</td>
<td>13.0</td>
<td>59.1</td>
</tr>
<tr>
<td>€127,000 – €316,999</td>
<td>16</td>
<td>13.9</td>
<td>73.0</td>
</tr>
<tr>
<td>€317,000 – €634,999</td>
<td>11</td>
<td>9.6</td>
<td>82.6</td>
</tr>
<tr>
<td>€635,000 – €1,269,999</td>
<td>9</td>
<td>7.8</td>
<td>90.4</td>
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<tr>
<td>€1,270,000 +</td>
<td>11</td>
<td>9.6</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>115</strong></td>
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</table>
Table 4. Sources of finance in different age categories

<table>
<thead>
<tr>
<th>Age Band (years)</th>
<th>Number of firms</th>
<th>Internal Sources of Financing %</th>
<th>External Sources of Financing %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Savings</td>
<td>Consulting revenues</td>
</tr>
<tr>
<td>&lt;2</td>
<td>12</td>
<td>43.0</td>
<td>27.0</td>
</tr>
<tr>
<td>2-4</td>
<td>46</td>
<td>10.0</td>
<td>13.5</td>
</tr>
<tr>
<td>5-9</td>
<td>20</td>
<td>9.5</td>
<td>28.0</td>
</tr>
<tr>
<td>10 +</td>
<td>18</td>
<td>10.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>14.0</td>
<td>19.0</td>
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</tbody>
</table>

Notes. This table reports the averages for each source of finance, as a percentage of total financing, for the 96 firms that provided financing information.
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Min.</td>
<td>Max.</td>
<td>Total attaining milestone</td>
<td>Milestone not (yet) attained</td>
<td>Missing</td>
</tr>
<tr>
<td><strong>Time to first:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>a. Beta</td>
<td>17</td>
<td>12</td>
<td>0</td>
<td>88</td>
<td>108</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>b. Employee</td>
<td>8</td>
<td>4</td>
<td>0</td>
<td>135</td>
<td>110</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>c. Consulting revenue</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>33</td>
<td>90</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>d. Product revenues</td>
<td>19</td>
<td>14</td>
<td>0</td>
<td>91</td>
<td>96</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>e. External funding</td>
<td>21</td>
<td>15</td>
<td>0</td>
<td>156</td>
<td>89</td>
<td>23</td>
<td>4</td>
</tr>
</tbody>
</table>

**Notes:** Column [6], 'milestone not yet attained': firms were asked to tick a 'not applicable' box if their business had not yet reached the particular milestone.
**Table 6.** Test Statistics for differences in the median time to attainment of key events in the formation process

<table>
<thead>
<tr>
<th>Event</th>
<th>Median Months Apart</th>
<th>Z-Score</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: Beta before external funding</td>
<td>3</td>
<td>-.77</td>
<td>.44</td>
</tr>
<tr>
<td>H2: Consulting revenues before beta</td>
<td>9</td>
<td>-5.10</td>
<td>.00</td>
</tr>
<tr>
<td>H3: First hire before beta</td>
<td>8</td>
<td>-5.79</td>
<td>.00</td>
</tr>
<tr>
<td>Product revenues after beta</td>
<td>2</td>
<td>-5.41</td>
<td>.00</td>
</tr>
</tbody>
</table>

**Notes:** this table reports the results of one-tailed Wilcoxon rank sum tests for the named comparisons.
Table 7. The sequencing of first beta and first external funding

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of firms</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Beta and external funding concurrently</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>B. Beta before funding</td>
<td>39</td>
<td>35.8</td>
</tr>
<tr>
<td>C. Funding before beta</td>
<td>40</td>
<td>36.6</td>
</tr>
<tr>
<td>D. Beta with no external funding</td>
<td>20</td>
<td>18.3</td>
</tr>
<tr>
<td>E. External funding with no beta</td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>F. No beta and no external funding</td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>109</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


Figure 1. Histograms for timing of key milestones

- Product beta (n=108)
  - 6 not yet attained

- Employee (n=110)
  - 4 not yet attained

- Consulting revenues (n=90)
  - 23 not yet attained

- Product revenues (n=96)
  - 18 not yet attained

- External financing (n=89)
  - 23 not yet attained

Number of firms

Months from start to milestone
Figure 2. Number of companies producing beta and receiving product revenues by the month: cumulative total
Venturing into the entrepreneurial unknown:

on entrepreneurship, intrapreneurship and extrapreneurship in the high-tech industries

Willem Hulsink & Dick Manuel

eShip Centre for Entrepreneurship
RSM Erasmus University
PO Box 1738, 3000 DR Rotterdam, The Netherlands
Correspondence: whulsink@rsm.nl & dmanuel@rsm.nl

Introduction

An article published in Newsweek in 1999 posed the following intriguing question: Can Extrapreneurship become a buzzword?¹ Expectations at the time were high: the related concepts of ‘entrepreneurship’ (=starting one’s own company) and ‘intrapreneurship’ (=starting up new business activities within a larger company) had already become part and parcel of many management courses and MBA programmes, so why wouldn’t ‘extrapreneurship’ become equally popular? Extrapreneurship is associated above all with starting up a business from an existing (parent) company in the form of an independent spin-off (or sell-off, in the case of a complete sale), possibly supported and prepared by a strategic investor and/or incubator. These activities could be considered complementary to entrepreneurship and intrapreneurship.

When we try to place the term ‘extrapreneurship’ and this relatively new practice of bringing together idea, entrepreneur, start-up capital, housing and other locational facilities and supporting services (in other words the creative combinations of entrepreneurs, idea providers, investors and incubators) within the broad and current literature on entrepreneurship, there are a few things that draw our attention. Whereas classic literature on entrepreneurship almost automatically assumes a heroic or clever entrepreneur who, basically because of his/her (pre)disposition (alert and smart, innovative-charismatic) as it were searches and finds market opportunities to exploit. In the case of extrapreneurship it is much more a question of market opportunities waiting to be exploited creatively by (latently) entrepreneurial people, or dynamic entrepreneurs, who are looking restlessly for interesting ideas and inventions

¹ http://www.businessweek.com/smallbiz/news/date/9902/e990209.htm
which they can market at a profit, or investors waiting for the creative genius to show up.

Shane & Venkatamaran (2000: 218) emphasize that what is important with regard to entrepreneurship is a ‘nexus’ that includes lucrative opportunities and entrepreneurial individuals seizing opportunities. By actively linking the generation of ideas, concepts and products and the spotting and seizing of opportunities ‘entrepreneurs’ make a positive contribution to the innovativeness, economic activities and dynamics of a country. When studying spin-off and incubation phenomena this definition is eminently important because it separates the idea/opportunity and the entrepreneur at an analytical level: especially when starting up spin-off companies or developing new companies from incubation centres it is not always evident that the entrepreneur and the idea/opportunity go together and are integrated. In this contribution we will further describe and amplify the term ‘extrapreneurship’, and its sister concepts entrepreneurship and intrapreneurship. A number of theoretical perspectives on corporate venturing, incubation and spin-off creation will be presented, and we will focus especially on the relationship between inventors, entrepreneurs and their parent companies (in the creation of spin-offs) or incubator organizations. Based on three possible forms, to wit corporate venturing, spin-off creation and incubation, and illustrated by cases involving young companies and their parent companies and incubators (e.g. Ordina and The Vision Web, CWI and Eidetica, Twinning and Siennix, and Shell and MTSA), we will further discuss extrapreneurship in the Netherlands and examine in what way it is different from entrepreneurship and intrapreneurship? To sum up, the objectives of this contribution are the following:

- What is extrapreneurship and in what way is it different from entrepreneurship and intrapreneurship?
- How does extrapreneurship manifest itself and which organisational forms of can be distinguished?
- What is the current state of affairs with regard to extrapreneurship in the Netherlands?

Perspectives on entrepreneurship

In one of the more recent definitions Shane & Venkatamaran (2000: 218) emphasize that what is important with regard to extrapreneurship is a ‘nexus’ that includes lucrative opportunities and entrepreneurial individuals seizing opportunities: ‘the field involves the study of sources of opportunities; the processes of discovery, evaluation, and exploitation of opportunities; and the set of individuals who discover, evaluate, and exploit them.’ By actively linking the generation of ideas, concepts and products and the spotting and seizing of opportunities ‘entrepreneurs’ make a positive contribution to the innovativeness, economic activities and dynamics of a country. When studying spin-off and incubation phenomena this definition is eminently important
because it separates the idea/opportunity and the entrepreneur at an analytical level: especially when starting up spin-off companies or developing new companies from incubation centres it is not always evident that the entrepreneur and the idea/opportunity go together and are integrated.

A parent company’s technology can, for instance, be commercialized by an external entrepreneur (actively supported by the parent company). It is also possible that inventors and idea-developers enter into a partnership with an incubator to develop their concepts further and start-up their own company. Within the spin-off process four different roles can be identified: the inventor, the (often internal) entrepreneur, the parent organization and the external investor (in the words of Roberts & Malone (1996): technology, originator, entrepreneur, source organization & venture investor). Ideally these four are all actively represented, but is also quite possible that, for example, the internal entrepreneur or the external investor are absent from the commercialization process. To facilitate a spin-off in such a situation the parent organization will have to persuade external extrapreneurs to take a licence for the developed technology and to work together with the internal inventor(s). If there is a lack of financial means in the initial stages, the parent company will have to look for venture capitalists or itself participate financially in the new product. In the start-up of new businesses supported by incubators similar roles can be identified, the role of entrepreneur/inventor, the incubator as active mentor of the start-up company (for instance by offering housing and coaching), the investment role of the incubator, and the incubator as liaison with professional service providers (specialized law firms, accountants, etc.).

Starting entrepreneurs rarely possess all the skills and tools required to set up a successful business. They are, however, inventive and curious in their search for small and highly uncertain market opportunities that, although they may be new and as yet untested, require relatively little investment (Bhidé, 2000). Rather than being able to fall back on wealthy investors, they have to make do with their own thrift and creativity; often helped financially especially by friends, relatives and former colleagues. Another group of entrepreneurs is supported in the early stages both by former employers and by professional backers with capital, ongoing contracts, references to new customers and suppliers; this reduces their unfamiliarity with the market. Although there are few new enterprises that have access to a stable network and sufficient resources from the start, spin-offs and incubatees put the resources and relationships to which their parent organisation or incubator gives them access to good use.

Nascent and start-up entrepreneurs can be divided into three groups on the basis of the extent to which they use a strategic network in creating and building their company (Elfring & Hulsink, 2005):

(i) the first category of starting businesses, the so-called lonesome cowboys, includes businesses that seem to appear from nowhere
and that manage to develop without any significant support from a strategic network.

(ii) the second category, the spin-offs or spin-outs, consists of starting companies that have received some kind of support from their former employer(s) (for instance training and coaching, housing, contract research, financing, etc.). An example of an organisation that gives birth to new companies on a regular basis is the Centrum voor Wiskunde en Informatica (CWI), which since 1990 has been responsible for about 10 spin-offs, for example Data Distelleries. Universities and large companies can also bring teams of employees together who set up their own company in an attempt to market the technologies on which they are working.

(iii) the third category consists of start-ups that receive support from incubators. This type of companies is created and developed within a strategic network of (potential) partners and professional service providers, by a specialised incubator (for instance Biopartner, Philips, European Space Agency, and in the past Twinning). In exchange for a share in the new company these incubators offers starting hi-tech enterprises easy access to a number of important services, like financing, housing, infrastructure and equipment, advice and coaching.

In one the first articles on extrapreneurship, Johnsson & Hagg (1987) point out that extrapreneurs operate between the hierarchy of entrepreneurship within a large organization (intrapreneurship) on the one hand and entrepreneurship within an anonymous market (traditional entrepreneurship) on the other. In the case of traditional entrepreneurship the entrepreneurs have already started a business; intrapreneurship involves active employees starting up projects and developing new business within the large existing company, either with passive or with active support from top level management; the extrapreneur is an entrepreneur who starts up a commercial activity with strategic partners (the parent company, a committed investor or incubator). The emphasis is on the relationship that exists or existed between the spin-off and the parent company and the relationship between the incubatee and the incubator. It is especially the connection with the parent company on the one hand and the partnership with the incubator that distinguishes spin-offs and incubated companies from regular autonomous start-ups that operate without external support. Extrapreneurship can be seen as a hybrid between hierarchical intrapreneurship and market-oriented entrepreneurship, where the dominant coordination form is the network (Powell, 1990). This kind of ‘network-entrepreneurship’ is characterized by a strong mutual dependence of the partners involved through a strong mutual trust and open communication and existing or future complementarities between the parent organization and the spin-off company or between the incubator and the incubatee.

We can distinguish three processes in which the network of an entrepreneur plays a vital role (Elfring & Hulsink, 2003; Hulsink, Manuel & Stam, 2004):
a) the ability to discover new opportunities
Networks in which the entrepreneur more or less actively takes part can be an important source of new ideas and lucrative opportunities. Hills, Lumpkin and Singh (1997) have discovered that about 50 percent of all entrepreneurs obtain new ideas through their networks. In addition, existing knowledge (Shane, 2000) and information (Fiet, 1996) are vital in the process from an idea to its eventual implementation. Both these variables are closely connected to networks, since network relationships can be viewed as ways to gain access to knowledge and information.

b) the ability to acquire resources
Entrepreneurs rarely possess all the resources they need to seize an opportunity. One of the crucial tasks of a new entrepreneur is to acquire, mobilize and deploy resources. In the early stages of a new company this is a difficult task due to the limited financial resources and the limited possibilities to generate internal resources and revenue. A close-knit social network (partner, spouse, relatives) can provide the founder/entrepreneur with the resources that are lacking (financial and human capital) and thus offer the company the stability it needs in the first phase of its existence. In addition, frugal networks facilitate the search for suppliers of essential resources (investors, technical partners and crucial customers), that in turn may provide the starting enterprise access to new resources.

c) the ability to acquire legitimacy
Acquiring legitimacy is crucially important when starting something that is considered innovative. Start-ups are faced with the liability of newness (Stinchcombe, 1965): young companies run a higher risk of failure than companies that have been around longer. Through their (existing or future) networks starting entrepreneurs can succeed in being associated with respected parties (Baum et al., 2000; Stuart et al., 1999). Suchman (1995: 574) defines legitimacy as follows: ‘the general perception or assumption that the actions of an entity are desirable, appropriate or just within a social framework of standards, values, convictions and definitions’.

Below we will focus on various aspects of extrapreneurship from four organization-theoretical points of view: the individual or team that starts up the new company (entrepreneurship theories), the parent company or incubators facilitating the new activities (the resource-based view), the division of tasks and complementarity between spin-off and parent company and between incubator and the incubatee (the resource-dependency theory), and, finally, the quasi-hierarchical supervision as a result of shared ownership, investment relationship and/or other contractual commitments between the parties involved (the principal-agent approach).

Entrepreneurship theories: the birth of new business
The dynamics behind corporate venturing, spin-off creation and incubation to a certain extent can be explained through the motives and forces that make people decide to become an entrepreneur. Various authors (Amit et al., 2000; Brandstätter, 1997) argue that personality is an important catalyst of entrepreneurship. They argue that specific character traits can make people want to start up their own company. Comparing starting entrepreneurs and entrepreneurs that take over an existing company, Brandstätter (1997) argues that entrepreneurs starting up their own company have the following character traits: more independent, higher emotional stability, more extravert and open to new ideas and experiences. Emotional stability and independence appear to stimulate the entrepreneur’s self-confidence, making him or her try something new and dare to venture. Various studies have shown that ‘willingness to take risks’, in addition to innovativeness and vision, is a relevant character trait in individuals deciding to set up their own company (Hisrich, 1990; Amit et al., 2000). That does not mean, however, that these entrepreneurial individuals are willing to take more or greater risks than non-entrepreneurial persons. Simon, Houghton & Aquino (1999) point out, for example, that people can start up their own company without being aware of the risks involved. Prejudices with regard to market potential (an overestimation based on small or selective tests) and ‘illusion of control’ can affect the perceived risks of the future entrepreneur.

Another aspect that is considered an important motivation to start up a new business is the prospect of high financial rewards (Hisrich, 1990; Brockhaus et al., 2001). Other studies conducted among entrepreneurs reveal, however, that independence, innovation, vision and a search for challenges are more important pull factors in starting up a new company than financial motives (Roberts, 1991; Amit et al., 2000). In some cases new companies are not started up totally voluntarily but out of virtual necessity in order to be economically successful. In these cases the factors involved are push factors. Examples are groups of immigrants using entrepreneurship to try and acquire a position within a society, or people that are not successful working for a company and who see entrepreneurship as a road to independence. Push factors within the parent company appear to be conducive to the creation of new companies. A stable working environment will lead to fewer spin-offs than a more unstable one (Roberts, 1991; Hisrich, 1990). A difficult relationship with the employer or the fact that management is not open to new ideas can motivate a person (or group of persons) to start their own company. This is especially true in the case of researchers, who after years of studying a specific subject, consider it a personal insult when their project is rejected (Garvin, 1983). As a result they will have to set up their own company if they wish to continue their work. In other cases the aspiring entrepreneur leaves a knowledge institute as a result of not being allowed to develop applications for an existing technology (Roberts, 1991).

The resource-based theory: the cooperative parent company and incubator
In addition to the reasons individuals have for starting up their own business there are other reasons that influence the emergence of specific organizational forms, such as spin-off creation, incubation and corporate venturing. The parent company or incubator have motives of their own for outsourcing specific activities through a spin-off or through the commercialization of a specific set of resources and services. We will identify these motives using the resource-based theory (RBT). Strategic motives, such as, for instance, an increased focus on the company's unique skills, will lead the parent company to decide to cooperate in externalization or to concentrate on incubation. Central to RBT are strategies aimed at the exploitation of company-specific resources and expertise (often simply referred to as resources) (Teece, 1998; Quinn, 1992). The assumption is that some companies can be highly profitable, not because they use scare tactics to ward off potential new entrants, but because they face considerably lower costs in comparison to their competitors due to resources that are both unique and hard to copy.

A central theme in RBT is that the resources of companies can lead to lasting competitive advantages. That being the case, why would a company choose to outsource specific resources to commercialize them externally? The strategic outsourcing of specific activities can provide a company with a greater flexibility and allow it to focus more on its core activities (Quinn, 1992). The term strategic outsourcing refers to the outsourcing of activities that can be performed better by external parties and thus add more value than by the company outsourcing them. The outsourcing company retains the activities in which it can excel. The outsourcing company can attract the best available contractor for those activities that are not part of its core business and/or in which it cannot excel. The result is a stronger strategic focus, which in turn can be used to expand the company's knowledge and expertise in such a way that it becomes the dominant party in the market segment it has selected. By outsourcing certain non-essential activities the organization is able to reduce bureaucracy and respond faster to market developments. Outsourcing also forces an organization to look for the most cost-effective provider of specific non-core activities. As a result the absolute costs to the company will be reduced.

When a parent company is unable to excel in a specific activity that is not a part of the company's core business, it can help create a spin-off. No matter how promising some business activities may be, to internalize them could lead to value destruction by the parent company spending precious resources like money, talent and time on an activity in which it could not possibly excel. It may be that the company's infrastructure is unable to deal with a specific task, for instance because the activity requires a response time for which the parent company is ill-equipped due to a lack of flexibility. In that case the parent company does not have the necessary competencies to perfect the recently discovered knowledge and technology. The solution may be to outsource the activity in question through the creation of a spin-off (or simply by outsourcing it). This will only happen in cases where the spin-off activity is
not a direct competitor of the ‘outsourcing’ parent company. In short, the strategic outsourcing of specific activities (preferable to an associated spin-off) can make the company more flexible and allow it to focus more on its core activities.

An incubator, a specialized professional service provider for start-ups and growing companies, is to some extent similar to a parent company, in that the incubator also offers a tailor-made range of services, resources and people to the young company. There are, however, differences as well: whereas the spin-off and the parent company know one another and the spin-off will be up and running in no time, the partnership between the starting entrepreneur (or enterprise) and the incubator has yet to develop. Incubation involves mutual selection processes and negotiations to arrive at a deal. The incubator can support the starting company by offering the portfolio of resources in which the incubator is specialized: housing, seed and/or growth capital, administrative services, management advice, hardware and software, networking, etc.

Resource dependence theory: the spin-off/parent company and incubator/incubatee partnership

Pfeffer and Salancik’s (1978) resource dependence theory looks at the mutual horizontal relationships between actors and argues that an organization will survive when it manages to acquire and maintain sufficient resources. These resources can be highly skilled personnel, a unique technology, a specific way of working and organizing, reputation or financial resources. Pfeffer and Salancik argue that organizations are effective when they manage to deal in a positive manner with internal and external stakeholders, on whom they depend with regard to acquiring or exchanging the resources they need. To measure an organization’s effectiveness it has to be clear which resources and stakeholders are most important. All organizations are connected to an (external) environment through their relationships with customers, suppliers, competitors, etc. This means that they depend on their environment for acquisition of the resources they require. As a result external parties have a certain level of influence within an organization. As far as the acquisition of resources is concerned, a spin-off or incubatee basically has two options. It can either obtain the resources it requires through the parent company or incubator, or it can try to obtain them externally (of course a combination of the two is possible as well).

The dependence of a company on its environment can shift over time. It is especially here that companies are vulnerable (Pfeffer & Salancik, 1978). A changing environment can affect the availability of a given resource. A spin-off, for example, will depend more on the parent company in its start-up phase than in its growth phase, which means that the young company faces a high degree of uncertainty concerning the products it wants to develop and its customers in that critical period. In a next phase the spin-off can detach itself more (or completely) from the parent company and acquire the much-
needed funds, resources and relationships through the broader and more diverse network it has developed over time.

The resource dependence theory argues that companies, including spin-offs, depend on external interest groups for the acquisition of their resources. Without resources a company will not survive. The most likely interest groups for a spin-off or incubatee when it comes to acquiring resources (at the outset) are the parent company or the incubator and their social capital in terms of customers, investors and suppliers. This network of parties will be more sympathetic towards the spin-off because of its background and contacts with the parent company. For their resources the spin-off and incubatee depend on various (external) parties. These parties have to consider the young companies legitimate before they will provide or exchange resources (Pfeffer & Salancik, 1978). This is achieved, among other things, by the young company's relationship with the parent company. However, in cases where there is a poor strategic fit between the two actors the new company's legitimacy may be adversely affected. By strategic fit is meant that the parent company in one way or another is involved with the spin-off, for example in the role of supplier, offers support in market-related and technological development, or helps in an advisory capacity. A precondition is that there be no conflict of interests between the two and they are not each other's competitors.

New companies spend a great deal of time acquiring the appropriate resources; especially in the early stages it is important for a new company to develop its (technological and marketing-related) competencies with the aim of marketing its products or services as quickly as possible. Any delay has a negative impact on the company's economic performance. A parent company and incubator could to a greater or lesser extent support the spin-off company or incubatee by providing it with physical resources such as buildings, money, machinery, equipment and raw materials, even if the support is of a temporary nature. The spin-off or incubatee can then focus on developing its competencies and on the market introduction. One resource that is difficult to come by for new companies is financial capital. Venture capitalists and banks pose extremely high demands when considering investing in young technology companies. Often these young companies have little more than an idea or concept, and the vision and best intentions on the part of the entrepreneurs involved to offer as collateral to potential investors. More often than not this makes investing in a new companies a risky affair. A spin-off has the advantage of being able to fall back on the parent company when it comes to the essential financing. Because spin-offs possibly have direct access to the parent company's financial resources and/or find it easier to gain access to other investors through the ties with the parent company, they have access to larger funds and can be more selective in choosing additional investors (Greene et al., 1999). This broader financial basis enables them to build a lasting competitive position, and for example to improve and commercialize their core technology more quickly.
The principal-agent theory analyses above all the vertical relationships between the principal (the owner or in this case the parent company) and the agent (those who carry out the work on behalf of the principal; in this case the agent is the spin-off) (Jensen & Meckling, 1976; Douma & Schreuder, 1992). The principal-agent theory looks at the (quasi-)hierarchical relationship between the principal, the party that has the authority and takes the decisions, and the agent who in this relationship has no leverage but who does have a technological head start vis-à-vis the principal. The central theme of this theory is how in these kinds of situations involving information asymmetry, whereby principal and agent have to work together towards a joint output, can best be given shape; this involves above all the use of monitoring, contracting and financial stimuli. Most business activities require a team effort, and the team of employees, managers and shareholders is as strong as its weakest link (Douma & Schreuder, 1992). When the input of team members is hard or impossible to measure, a free rider problem can arise. Individuals can decide to work without dedication or not to work at all. Monitoring the team members (involved in carrying out the work) can in principle prevent unproductive behaviour. A similar information asymmetry occurs between the incubator as the principal and the incubatee as the agent: the incubator makes the decisions concerning the investment in a new company, without knowing the exact quality of the entrepreneurial team or the status of their product or service.

In this context the reward and monitoring structure that is construed in complex situations is considered very important to the success of an economic activity. The same can also apply to the spin-off and incubatee. The (financial) reward structure for the entrepreneur could be important in ensuring the spin-off’s objectives, as well as those of the parent company are realized. As soon as the idea of having an own company has entered the mind of the employee, his motivation to work hard for his employer will greatly diminish. Things are different for the employer: he will want to know if the employee really wants to start his own business and who and what he intends to take with him. This complex situation is characterized by a conflict of interests and information asymmetry. It is important to find an organizational or contractual form that sufficiently takes the motives and possible rewards of both parties into account as well as the information both parties require about each other. In this type of situation a spin-off construction stimulates the employee/entrepreneur to manage the activities in the best possible way, and the parent company to cooperate under certain conditions (for example: financial participation and commissionership, continuous purchase contracts, etc.). The transfer of the parent organization’s knowledge to the spin-off, for instance, often takes place in the form of licences. These can be exclusive to ensure the spin-off has sufficient time to exploit the licensed knowledge, or to retrieve investments that have already been made. In this respect there can also be a competition clause to make
sure the parent company and the spin-off will not operate as each other's direct competitors.

**Corporate venturing**

Corporate venturing can be described as the strategic activities of large companies aimed at realizing innovative growth through the development of new projects or ventures or by founding (or further develop) new companies outside of the closely knit company structure (Berenschot, 2000; Jacobs & Waalkens, 2001; Rijnders & Elfring, 2001). There is a difference between internal and external venturing: whereas internal ventures fall within the responsibility of top level management, external ventures fall within responsibility of the corporate venture fund’s management. Internal corporate venturing of existing companies is aimed at realizing endogenous growth through the stimulation of the entrepreneurial ambition of the employees (product and service development) or by developing opportunities for the company's non-core areas or for redundant employees (outplacement). External corporate venturing involves strategic alliances between large companies and smaller companies or direct investments by large companies in start-ups. Large companies can invest strategically in smaller companies for profit reasons (financial return on investments) and/or a (phased) exogenous influx of innovativeness via a junior partner through access to new ideas, talent, markets and/or technology. Whereas small companies often work together with large companies because of benefits related to financing, reputation, access to distribution and R&D expertise, large companies benefit from the access to new technology/market combinations and/or the exploitation of radical innovations in the longer term, or the acquisition opportunities of the young technology company.

Within large companies there is a fundamental uncertainty about the future success formulas of innovative concepts and companies. At work floor and middle management level of the companies there is, however, a wealth of ideas regarding new products and new business opportunities; if companies fail to provide an outlet for these ideas the more entrepreneurial employees will move on to more inspiring companies or start their own enterprises. A venturing strategy aimed at developing these promising ideas can prove helpful here. A venturing strategy can provide fertile ground for new ideas, allowing entrepreneurial employees to seize opportunities and providing time and resources. In addition to giving those employees (some) autonomy, top level commitment to allow employees to experiment with the development of new ideas and business opportunities is important as well; top level management can, for instance, provide additional facilities (capital, used equipment, contacts, etc.) (Rijnders & Elfring, 2001). Companies can include an explicit innovative objective in their mission statement - for example 25% of the company turnover to be associated with new products - or set up an internal fund for employees with good ideas that are not directly related to the company’s core business. Internal entrepreneurship can also be programmed by generating promising ideas and commercial activities at
middle management level and encouraging the work floor. The company will have to set up an adequate package of reward measures for this kind of dynamic employees when the new product or service proves to be commercially successful.

Another way to stimulate innovative entrepreneurship is for companies to set up and exploit an external investment fund – possibly in cooperation with financial partners – aimed at facilitating spin-offs and participating in small innovative companies. In recent years, large companies like Intel, Philips, DSM and Nokia have set up corporate venture funds to be able to develop strategic initiatives at some distance from the parent company. Although the level of autonomy, the mandate and the connection with the parent company vary, these corporate venture funds try to fill the gap between internal corporate ventures and professional venture capital companies in an attempt to combine the two (Rijnders & Elfring, 2001). The focus on certain technologies and markets is derived from internal venturing, whereas the reward structures with shares and options in the new ventures are based on experiences from venture capitalists. In most cases investments will be made both in spin-offs from the parent company and in independent existing and start-up companies. Depending on the core company’s priorities these satellite companies can either be sold or, if there is a clear strategic fit, integrated into the core company.

Box 1 Corporate venturing: The Vision Web

Besides driven by an entrepreneurial spirit, the Vision Web is also inspired by the principles of Ricardo Semler, such as management without control, full internal transparency, cell splitting (when reaching a critical mass of 150-200 people in a unit) and let talent find its place. This Brazilian entrepreneur/management guru had not only become famous with his bestseller The Maverick but also with the implementation of some of these principles in his own company Semco: ‘letting employees choose what they do, where and when they do it and even how they get paid, and share the profits.’ The founders of the Vision Web met in the middle of 1995 at one of Semler’s seminars and were full of enthusiasm to set up their new company, a company that would have to be based on a number of pillars, such as ‘talent before structures’ and ‘spontaneous entrepreneurship’. In addition, they believed in an enterprise with a very strong focus on different product-market combinations and what would be a better way to achieve that than through a network organisation? This company specialised in IT architecture was called Solvision and it was officially founded on January 1, 1996. Its primary focus was on project management and IT architecture consultancy. At that time the name The Vision Web did not yet exist. This ‘umbrella’ name emerged in 1998 when the second label – Change Vision – was launched. Change Vision, which focuses on change management, was the first new company within the Web, and more were to follow. Consequently, they founded an implementation company called Crexx. This company makes websites, with a focus on combining e-commerce, content, call centres, websites and telephony. Later, customer demand for more functionality led to the foundation of The Lodge, an infrastructure service provider. FiNext was set up for the financial market. FiNext serves as parent organisation for the Vision Web’s financial activities. An example of this is the joint venture Intersolutions.
The starting point is that The Vision Web always maintains a majority interest in its companies and that a shared service centre is responsible for the bookkeeping and legal affairs of all the members of the Vision Web. The Vision Web wants to be the best in stimulating the talents of its employees and in combining talents and market opportunities. The philosophy is straightforward: the financing is arranged internally and the groups of professionals after their investment plan has been endorsed by the management team of Web-bers can take their own steps to increase that amount and run their internal venture by themselves. It was our clear target to develop into an internal and external business network. For us, e-business and a network organisation are more than something electronic. It has to do with leadership structures and how you organise yourself”. At the end of 1998, The Vision Web considered going to the stock exchange. Preparations for this were very discouraging and a public offering would have led to many unwelcome changes. In the end, they decided not to go through with it. As a result of these deliberations an Advisory Board of senior executives was set up, which is very important in providing advice and the network to reach customers.

The first five years of The Vision Web were years of unbridled growth. We wanted to grow as fast as we could, in order to create a place in the Dutch market. It was not hard to find good people, although in the first life phases it was hard to convince the employees’ environment that it was a good idea for them to leave a renowned company to work for a small start-up like Solvision. In later phases finding people no longer presents a problem. The new employees had to fit in with the company. We never advertised, but just called people we knew. Initially, they were people that one of us knew. After a while the network expands, because the people we hired knew other people. In 1995, we were in a pub, and the first thing we said was: “Wouldn’t it be great to have an office just like this, a place were employees can meet, where they come together, exchange knowledge, can invite customers”. Employees can also work from home: everyone is provided with a network connection and a laptop computer, which means they can log in anywhere. That doesn't require a big office. Although in terms of “idea” this was not a new thing in the Netherlands, it was in terms of “actually doing it”. In March 1997, we went to the Grand Café in Delft. This building has also been important for the reputation of our network organisation, as a place where the Vision Web consultants could meet (as their home base), but also as a nice location where the Vision Web people could meet with their customers.

After an unbridled growth from 1995 to 2000 growing to a workforce of about 500 employees (with hardly any turnover) and to about 30 labels and boutiques (i.e. internal ventures), the company reached a stabilisation stage and was acquired by the stockmarket-listed IT-services company Ordina at the end of 2003.

**Spin-off creation**

Increasingly, the universities and public research establishments are considered incubators of future commercial ideas and new business activities. Presently, virtually every university in the Netherlands has its own incubator and/or science and technology park (or is planning to set up one). Universities are also setting up (or expanding) patent and licensing agencies to exploit or manage exclusive knowledge and patents, and they are actively involved in creating temporary entrepreneurial positions for graduates and in
supporting academic spin-offs and providing financial resources, etc. In addition to universities and MTI's, spin-offs also emerge in the private sector, when a certain division or business activity is separated from the parent company. Within this group of entrepreneurial spin-offs the following distinction can be drawn:

i) equity carve outs and spin-outs, resulting from restructuring activities or the desire to commercialize radical innovations (disruptive technologies) through an independent division (Anslinger et al., 1997; Christensen, 1997);

ii) entrepreneurial spin-offs, where entrepreneurial employees start a new company to commercialize knowledge they have acquired at the parent company (Roberts & Malone, 1996; Lindholm, 1997; Elfring & Foss, 2000).

Unlike entrepreneurial spin-offs, which are relatively common in the Netherlands, spin-offs from companies listed at the stock exchange are rare. Exceptions to this are Vendex, which separated its employment agency from its retail activities, and KPN, whose PTT Post division now operates independently, and earlier Philips, which externalized ASML. An entrepreneurial spin-off can be defined as follows: An employee leaving a company to start his own enterprise. To qualify as a genuine spin-off, there has to be an official transfer of rights, such as assets of knowledge, from the existing company to the new enterprise (Lindholm, 1997: 332). The knowledge being transferred from the parent company to the spin-off can be explicit, for instance in the form of patents or installations, but it can also be implicit in the case of skills and expertise that are difficult to codify (Teece, 1998). Compared to regular start-ups spin-offs develop and present themselves differently. Spin-offs involve experienced and motivated employees with relatively secure positions within an established company leave that company to start their own company. The support that the parent company offers the new enterprise helps reduce the personal risk to the would-be entrepreneur and as a result his chances of success increase.

The transfer of knowledge and technology which has been developed in the parent company to the spin-off often takes place in the form of licences. These can be exclusive in nature to ensure that the spin-off has sufficient time to exploit the knowledge and to earn back the investments it has made. There may be a competition clause to prevent the parent company and the spin-off from competing with each other head on. This makes it easier for a parent company to adopt a favourable attitude towards the spin-off. Elfring and Foss (2000) have drawn attention to the relationship that develops between the parent company and the spin-off: will the spin-off compete with the parent company or not? Elfring and Foss draw a distinction between the virtuous spin-off, which is beneficial to the parent company, and a vicious spin-off, which has a negative impact as a result of direct competition. In the case of the virtuous spin-off the activities of the new company complement the core activities of the parent company, or they are part of the original
company's value chain. In the case of a vicious spin-off both the parent company and the spin-off offer the same product-market combination(s) and their relationship is characterized by rivalry.

The importance of knowledge transfer to a spin-off becomes clear in a study conducted by Lindholm (1997). In his study, Lindholm compares entrepreneurial spin-offs to regular start-ups with regard to their growth speed and innovative capability over a ten year period. As far as the innovative capability is concerned he found hardly any differences, as both groups had an equal amount of patents. However, the growth witnessed in the spin-offs far exceeded that encountered in the regular start-ups. Lindholm argues that the relationship with the parent company will indirectly influence the growth and performance of a spin-off. Spin-offs are taken seriously much more quickly by external parties such as customers and investors and as a result they have a better chance of being able to acquire (additional) resources. In addition, spin-offs often get (access to) physical resources, patents and/or financial capital from the parent company. The close contacts between a spin-off and its parent company mean that, for example, a spin-off has a developed technology or product at an earlier date and thus is able to expand its activities more quickly. As a result spin-offs are able to market a finished product much sooner than their regular counterparts. They can also free resources more quickly for other activities, such as marketing their products, since they have to spend less time developing their products. Roberts (1991) comes to the same conclusion; he found that 87% of the entrepreneurial spin-offs he investigated considered the technology/knowledge they had acquired at the parent company to be important to the start of the spin-off.

Like elsewhere in the world, in the Netherlands new enterprises emerge from other enterprises and knowledge institutes (spin-offs). The reasons for this vary from no longer fitting in the company's strategy, a lack of entrepreneurial spirit on the part of the parent organisation needed to develop and exploit the new opportunity quickly, the high risk involved in the opportunity which may put too much pressure on the revenues of a listed enterprise, making social investments in the context of socially responsible and sustainable entrepreneurship, transferring knowledge to society by government-funded knowledge institutes, stimulating entrepreneurship for politico-economic reasons and thus creating employment by setting up incubators. We present two case studies of parent organisations and start-ups: enterprise Shell and its MTSA spin-off and knowledge institute CWI with Eidetica as one of its spin-offs.

**Box 2 spin-off creation: Shell Netherlands and MTSA Technopower**

In 1990, Shell Netherlands created the Shell Participation Association for small Enterprises (SPMO), with the intention of providing an impulse to small-scale businesses by providing venture capital and, where needed, management support. Small companies also have access to Shell’s knowledge with regard to (alternative)
energy and the environment. The target group includes innovative and/or technological start-ups. Usually, these are small companies that either run an increased risk due to the position in which they find themselves and/or find it difficult to acquire financial support elsewhere due to a lack of capital.

SPMO is part of the Social Investment programme. This is one of the company's expressions of sustainable entrepreneurship, something Shell has been formulating more explicitly in recent years. Shell supports projects that aim explicitly at groups outside of the company. Supporting entrepreneurship and knowledge transfer is an example. Shell aims especially at supporting companies with new sustainable and innovative products. Wherever possible and when desirable the aim is to acquire financial backing from several parties (syndication). The fund provides companies with seed capital of € 25,000 to € 100,000 in the form of shares or deferred loans. Also, SPMO supervises management buy-outs, like in the case of MTSA Technopower.

MTSA Technopower (originally Multi Technical Services Arnhem) was founded in 1994. At the time it was the technical support division of Billiton Research Arnhem (BRA), a part of the Shell International Research Company (SIRM). BRA was responsible for research and development in the area of metal alloys, corrosion and inspection for Billiton and Shell companies. To that end the support division developed and built process installations and equipment. In 1994, as a result of a further concentration on energy extraction and exploitation, Shell decided to sell BRA to the South-African company Gencor. Because Gencor had its own R&D division, BRA Arnhem was to be closed down. The support division's management saw an opportunity to continue as an independent company developing installations and equipment for the market. Shell responded positively, because this would save the company any negative publicity concerning the closure of BRA. Through autonomous growth and acquisitions MTSA Technopower has grown from 14 to 75 employees. For example, the Technology department of KEMA Nederland was taken over under the name MTSA-KEMA Technopower.

During MTSA's start-up process the company received support from SPMO, which also gave advice during the negotiations with Shell management. During these negotiations and the MTSA’s subsequent creation the company has not tried actively to realize a fit between the parent organisation and the spin-off. There was no practical need for this anyway, since MTSA’s activities were not a part of Shell’s core activities. The entrepreneur has found that MTSA is seen as a serious candidate by potential clients and investors because of its Shell-related background. MTSA did not receive financial capital from SPMO, although it did receive other financial support. In the negotiations with Shell it was agreed that in the first six months Shell would provide 80% of the new company’s turnover. In the period following that MTSA would have to generate 80% of its turnover from the market, something it managed to do easily.

During MTSA's start-up phase, SPMO regularly organised meetings where start-ups with a Shell background could get together and exchange information. The MTSA entrepreneur managed to arrange various assignments at these meetings. The employees that had come over from the parent organisation brought in complementary expertise and skills with regard to the development and construction of process installations for the Billiton and Shell companies, which could now be used to develop installations for the market. The transfer of physical resources, in the
form of the BRA plant and its heavy process installations, at a reasonable price, has also contributed to the successful continuation of MTSA.

**Box 2b spin-off creation: CWI and Eidetica**

The Centrum voor Wiskunde en Informatica (CWI), formerly known as the Mathematical Centre (MC), was founded in 1946 as a national research institute in the area of mathematics, with an emphasis on applied mathematics. Within the MC, the first Dutch computers were developed and calculation services were carried out for the Dutch industry and insurance community. Computer development was made independent with the help of the Nilmij insurance company. The activities and the staff involved were transferred to a new company called Electrologica. This company can be considered the first of the CWI’s spin-offs. In July 2000, the CWI’s spin-off policy was formalised, when CWI Inc., the in-house incubator, was founded.

When the CWI was founded the transfer of knowledge to the market was formulated as one of its core activities. Facilitating the creation of spin-offs fits in with this policy. In addition, an active spin-off policy leads to extra – albeit limited – financial revenues that can be used to fund high-risk research. Also, the spin-off policy creates new career opportunities for CWI staff. The ideas and technologies that are designed within the CWI are transferred to the researcher. In exchange for a minority share, CWI Inc. offers limited amounts of seed capital, housing and infrastructure. The actual commercialisation is and stays the responsibility of the entrepreneurial researcher.

Eidetica was founded in 1998 by Annius Groenink and Stijn van Dongen, two of the CWI’s former researchers. The direct cause for the start of Eidetica was a specific idea for a product in the two founders’ area of expertise: a specific software service that could identify trends within data and text. When it started Eidetica had access to patented autoclassification software that had been developed within the CWI. Initially, Eidetica’s ambition was to market the trend-watching software. However, due to a lack of market interest this did not seem feasible. The entrepreneurs then embarked on alternative business activities by developing new technologies and services in cooperation with their clients. Since then Eidetica focuses on software applications for the software manager. The company now provides a hosted knowledge concept involving search methods and text mining solutions. Eidetica provides software as an Application Service Provider (ASP).

The CWI has supported Eidetica in the following ways. In the first year the CWI was responsible for a majority of the new company’s turnover. However, Eidetica managed to become financially independent soon after it was founded. After its first year it had to generate most of its business elsewhere. Also, the CWI has made it easier to gain access to the other spin-offs, external financiers and potential clients. One of the entrepreneurs was able to start developing Eidetica’s core technology while still working for the CWI. An investigation indicated that the CWI had no rights with regard to Eidetica’s technological knowledge. In exchange for the above-mentioned support, the CWI was given a 25% part of Eidetica’s initial nominal shares. Through funding, Twinning also took part in the company’s share capital. Twinning also provided housing and a network of heavyweights in the area of management and financing. In 2002, Eidetica was taken over by another Twinning enterprise called Filter Cooler Technologies, a company based in Hendrik Ido Ambacht near Rotterdam. The amount involved has not been published. Eidetica
became the R&D division of Filter Cooler Technologies and focuses on advance search technologies, content mining and intelligent ICT solutions.

Incubation

The American organization for (business) incubators, the National Business Incubation Association (NBIA) uses the following definition of a business incubator: ‘an economic development tool designed to accelerate the growth and success of entrepreneurial companies through an array of business support resources and services (www.nbia.org).’ According to the NBIA, the effectiveness of incubation is measured on the basis of economic value creation, both for the incubatee and the incubator. The concept of business incubation usually includes four types of facilities for start-ups and young (technology) companies: offices, dust-proof spaces and limited laboratories, equipment, etc.; access to financial resources and the investment funds of the incubator and its partners (in the shape of subordinated loans or shares); access to a network of portfolio companies and often a select number of core companies; and, last but not least, advice and coaching with regard to human research management, accounting, legal matters (for instance the company's legal status, intellectual property, etc.). In addition to the basic services of housing and office and research facilities and advice and coaching, incubators also provide facilities aimed at forming a strategic network (new contacts, partners, deal-making, etc.) and reinforcing the young company's mission and focus, as well as its techno-economic and financial potential (drawing up a business plan, financing, sourcing). These services are intended to maximise the chances of success of the young companies (the survival objective), to provide sufficient resources for the new technology company to grow (the development objective) and at the same time to accelerate this growth and expansion into new markets and technologies towards long-lasting success (the acceleration objective) (Hansen, Chesbrough, Nohria & Sull, 2000). The traditional incubator is a knowledge institute (such as a university or R&D institution) where potential entrepreneurs develop ideas for starting up new companies. Initially these knowledge institutes had little or no incubator facilities and as a result there was in many cases a flight of ideas, knowledge and high-quality entrepreneurial talent.

A commercial interpretation of a network-driven incubator is provided by Garage.com and Idealab! (Barrow, 2001; Richards, 2002). Garage.com is a kind of platform aimed at bringing together a select group of starter with ideas and investors with money through the Internet and intranet. When two companies hook up and an investment deal is made, Garage.com receives 5% of the start-ups capital. Garage.com itself makes no strategic investments in small companies, but it earns its participation when it has successfully facilitated the investment by a business angel in a start-up company (as a commission). Another example is Idealab!; here the ideas are provided by the incubator’s professional entrepreneurs themselves. With Idealab! the creativity comes from within (concepts and business plans from outside the
company are not accepted): once founder-entrepreneur Bill Gross and his employees have identified an opportunity, a team of ‘entrepreneurs’ from within and outside the company is put together to translate the idea into a business plan. To develop a prototype for a web service (site) Idealab! provides the venture team with start-up capital and with management support. When the business plan is successfully implemented a company is set up and the capital is divided equally between Idealab! and the team of entrepreneurs. In addition, the start-up team is appointed a senior manager from Idealab! or one of ‘its' companies, and it is urgently requested to locate itself on the Idealab! premises. Examples of portfolio-driven incubators are US-based CMGI, Softbank from Japan and Newconomy in the Netherlands. CMGI and Softbank recognized the Internet’s potential as early as 1996 and 1997, and in the following years they built up an extensive portfolio of participations in Internet-companies and sought to develop a range of mechanisms to provide companies with access to complementary knowledge and experience. Recently, however, they have developed into builders of strategic networks or keiretsus. They buy existing companies and through their majority interest are in a position to force the various companies in which they have invested to work together and realize synergies. However, as has become clear from recent events involving CMGI, Softbank and Newconomy, these incubators have been insufficiently successful in forging a strategic network of participations into a coherent conglomerate.

Box 4 Incubation: Twinning and Siennax

A well-known Dutch incubator is Twinning. The rationale behind the development of special facilities and a network for starters within the Twinning concept was the relatively low yield of research efforts and disappointing innovativeness and dynamics, in particular in the Dutch software sector (Ministry of Economic Affairs, 1996, 1997). The Dutch software sector was lagging internationally because it was based on outdated technology and there was an insufficient flow of public knowledge to the market sector. In the mid-90’s, Dutch venture capitalists were reluctant to invest in start-up companies (relatively little money was being spent on working out an idea and business plan and on prototyping). Instead, they preferred investing in, especially, American technology companies or in existing companies at home (for instance the restructuring of large companies or management buy-outs) (Booz-Allen & Hamilton, 1998). Not only the venture capitalists, but the Dutch ICT-companies as well, focused predominantly on the short term and they were almost exclusively service-oriented (rather than looking at product development), which resulted in a conservative business climate (Den Hertog & Huizenga, 1997; Ministry of Economic Affairs, 1999a).

Twinning’s origins lie with the increased attention for ICT at a number of government departments in the 1990s. The Software Actionplan, and shortly after the National Action programme Electronic Highway were published in 1996. They were followed by a study by Booz Allen Hamilton into the Dutch ICT sector. The idea to set up Twinning, initially called Twincubators, had by then been born. The incubator Twinning provides special facilities (such as housing, investment funds, access to a high-quality infrastructure) and a support network of mentors, professional service
providers and financiers for starting entrepreneurs in the ICT-sector). First of all, there is the Twinning Network of renowned national and foreign ICT-professionals that can give starters advice concerning the technical and market-related potential of certain ICT-products, establish contacts with suppliers, distributors and clients, and coach the starters from a distance and on essential issues. Secondly, start-ups can rent (office) space at the Twinning Centres at the going rate and gain access to high-quality ICT-facilities and professional services (accountancy, legal services, management consultancy). And thirdly there are the Twinning Funds: the Startfund consists of convertible subordinated loans or shares in young ICT-companies (with a € 200,000 ceiling) and the Growthfund aimed at growing companies based on a 50/50 funding between Twinning and the various participating investors taking part in the fund (with a € 1 million ceiling).

In October 1998, the first Twinning Center is opened in Amsterdam by the then Minister for Economic Affairs. After Amsterdam (Autumn 1998), other Twinning Centers are opened in Eindhoven (Spring 1999), Enschede (Autum 1999 and Delft/Rotterdam (Summer 2000). Twinning has since terminated its operations. From October 2003 onwards, the existing portfolio is managed by Sienna (not to be confused with Siennax) Holdings Europe in Amsterdam.

Siennax was founded in May 1998 by five ex-employees of Origin (the result of the takeover in 1996 of BSO/Origin by Philips C&P). Two of them are (and continue to be) part of the company’s board: Herb Prooy (CEO) and Michiel Steltman (CTO). Siennax can also be considered a spin-off of the enterprise Origin, since that is where its founders acquired their knowledge and relationships, albeit much to Origin’s dissatisfaction. Initially the idea was to provide consultancy services, in line with Origin, with a focus on the Internet. After a few months the idea of developing a kind of Intranet-like service emerged.

This activity was placed with the second company called Il Campo. The developments of this product are funded in part with the revenues from the consultancy. Two business angels were prepared to provide external funding. In 1999, Prime Technologies Ventures came aboard as lead investor. Twinning also participated. Il Campo was reincorporated into Siennax, and Siennax moved into the Amsterdam Twinning Center, which was considered an inspiring environment. It was also the time of the Internet hype. It helped to be associated with Twinning. Associating with fellow Twinning companies was fun, but beyond that it yielded nothing. Via Twinning, Arthur Anderson was hired, the accountancy cost nothing, the advice was expensive.

Currently, Siennax has 70 employees, offices in the Netherlands (Amstelveen), Germany and the US. Its shareholders are the company’s management and staff, Prime Technologies Ventures, ABN AMRO Participaties, Siena, Residex, HGP (Netherlands), BHF Bank (Germany) CapMan Capital Management Oy and Sonera Corporation (Finland).

**Conclusion**

Thus far few members of the public at large are familiar with the concept of extrapreneurship and the chances of it becoming a buzzword any time soon are slim. But although the overall term used to describe the setting up of
creative combinations of entrepreneurial talent, ideas and knowledge, investments and facilities has not yet managed to achieve popularity, certain elements, like spin-offs, incubators and corporate venturing, have fared decidedly better, both within and outside of the Netherlands. A number of elements can be distinguished. The first one is the individual deciding to go outside the limits imposed by the parent company and set up his or her own business or start from scratch with the support of an incubator. The second, and key, element in the creation of a spin-off or incubatee is the parent company or incubator: whether or not either of these support the budding company (and the degree to which they do so) and what added value they bring to the start-up. The third element is related to the exchange taking place between the spin-off or incubatee on the one hand and the parent company or incubator on the other and the form in which that exchange takes place. The fourth element has to do with the relationship between the spin-off or incubatee on the one hand and the parent company or incubator on the other and the degree to which the parent or incubator on the one hand monitor the spin-off or incubatee’s activities, and on the other hand provide the new company with various resources, facilities and relationships.

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What's the way?

The foreign entry mode selection process of innovative and manufacturing-based start-ups

Willem Hulsink and Robert-Jan van Eijk

eShip Centre for Entrepreneurship
RSM Erasmus University
PO Box 1738, NL-3000 DR Rotterdam, The Netherlands

correspondence: whulsink@rsm.nl

Introduction

One manifestation of our globalizing world is the emergence of start-ups that have an international focus from inception. The international activities of these firms, which are called ‘born globals’ (Knight & Cavusgil, 1996), ‘infant multinationals’ (Lindqvist, 1991) or ‘international new ventures’ (Oviatt & McDougall, 1994), have received an increasing amount of attention from researchers over the past years. These studies examine the characteristics of start-ups that have decided to internationalize almost directly after their creation, their motives for international expansion, the differences between international start-ups and non-international start-ups, and the entry modes they have used (Brouthers & Nakos, 2004).

This study is focusing on the foreign entry mode choice of start-ups. International entry mode choice is considered as a critical strategic decision in the internationalization process of dynamic firms (Anderson & Gatignon, 1986; Root, 1994; Hill et al., 1990; Lu, 2002). The foreign entry mode describes the way an overseas’ market is entered, whereby the possible entry modes differ from each other on the degree of control, risk, return on investment and resource commitment. Should a firm for example enter the foreign target country by using foreign agents or subsidiaries, licensing partners, joint ventures, acquisitions, or set up a greenfield production site? The entry mode decision is critical because it determines largely the success of a company abroad and once a particular entry mode has been chosen it is often expensive and time-consuming to change it. The traditional studies of entry mode selection are mostly focused on established firms, either large multinational companies or mature small- and medium-sized firms. The specific reasons of international start-ups to select a particular entry mode have not been studied in great detail (Brouthers & Nakos, 2004).
The specific focus in this study is on innovative start-ups. These innovative firms produce products which are “new to the world” (Tidd, Bessant & Pavitt, 2001). Innovative start-ups face a lot of uncertainty compared to firms with traditional products and established organizations. The innovative product is unknown to the marketplace and so is the effect of the product for the customer. This uncertainty makes innovative start-ups an interesting group for entry mode choice research. Few researchers have examined the entry mode choice of innovative start-ups or small firms, and if so, the software or ICT industry is very prominent among them. Studies by Jolly, Alahuhta & Jeannet (1992), Bell (1995), Brouthers, Brouthers & Werner (1996) and Coviello and Munro (1997) have examined the entry mode choice in relation to small software and ICT-related firms. The software industry, however, is not easily comparable with traditional manufacturing industries, because the additional service-intensity of the industry and the ease with which software can be distributed electronically have a very specific effect on the mode of entry decisions (Coviello & Munro, 1997). This study focuses on innovative start-ups that produce novel tangible products and seek additional investments in manufacturing and distribution facilities and warehousing. This study seeks to obtain insight in the entry mode selection process of innovative start-ups which act in a manufacturing-based environment. The primary research question guiding this study is:

How do innovative and manufacturing-based start-ups make their first foreign entry mode choices and what are the most important factors shaping them?

Since most studies have looked into the entry modes of established companies, our early internationalising firms chosen for the empirical case studies had to meet certain selection criteria: besides a presence in their home market (i.e. the Netherlands), they should also be active in foreign countries or in the process of their first foreign market introduction. Another criterion these international new ventures had to meet, was that they were manufacturing-based, i.e. developing and producing an innovative and tangible product. Software developers were excluded from this research, because of the ease with which software can be globally distributed via electronic means. Furthermore the firms selected for the case studies should be independent, i.e. not part of a parent company at the time of their first foreign market introduction, and should have had their first foreign entry less than five years ago. The firms that met these criteria and which were selected for our case studies were Ergodynamics, VPInstruments and Sunshower. In-depth interviews with the founders of those firms who were involved from the initiation to the early growth stage were held in order to understand the rationale behind the entry mode selection process.

Innovative start-ups and their internationalisation strategies

There are many definitions of internationalization. Mathews (2002) defines internationalization as “the process of the firm’s becoming integrated in
international economic activities”. This definition includes the total operations (strategy, structure, resource etc.) of firms and whereby the term “integration” can mean that the process is pull or push orientated. Generally, growth of a company is responsible for internationalization. Dunning (1993) distinguish four main motives for a firm to internationalize: (i) the resource seekers are prompted to invest abroad to acquire specific resources at a lower real cost than can be obtained in their home country; (ii) the market seekers invest in a particular country or region to supply goods or services to markets in these countries (especially countries with a small home markets are able to achieve economies of scale by internationalization); (iii) the motive for efficiency seekers to go international is to rationalize the structure of established resource-based or market-seeking investment in such a way that the investing company can gain from the common governance of geographically dispersed activities (e.g. through economies of scale and risk diversification); (iv) the strategic asset seekers go abroad to acquire the assets of foreign corporations, to promote their long-term strategic objectives, especially that of sustaining or advancing their international competitiveness.

The stage theories of internationalization can be described as an incremental process in which a firm passes through several stages. It states that the internationalization process of a company is a gradual process. Andersen (1993) distinguishes two different theories: The Uppsala internationalization model (U-Model) and the Innovative-Related internationalization model (I-Model). Johanson & Vahlne (1977) introduced the Uppsala model of internationalization. The model states that internationalization is a long gradual process of learning about foreign markets and subsequently committing resources to increase the level of international involvement. The Uppsala model describes the process as the interaction of a company, on the one hand, incrementally developing its knowledge about foreign markets and its operations and, on the other hand, committing increasing amounts of resources to these markets, hereby continuously increasing the degree of internationalization of the firm. Through commitment of foreign business activities the commitment to this market increases because it gains experiential knowledge of this market (Johanson & Vahlne, 1977). An important theme in this process is “psychic distance”. Johanson and Vahlne (1990) define psychic distance: ´...as the sum of factors preventing the flow of information from and to a market. Examples are differences in language, education, business practices, culture and industrial development.` Psychic distance has an effect on the flow of information between the company and the market. The Uppsala model expects companies to start their internationalization from countries that are psychically close to them. Here they perceive the best opportunities and a minimal level of uncertainty.

Like the U-Model, the I-Model describes a company’s internationalization process in stages. The I-Model considers internationalization as an organizational innovation (Räisänen, 2003). The focus is mainly on the export activity, which is considered the first step to internationalization. The differences of the two models lie in their way of explaining the rationale
behind a firm's internationalization. In the U-model, the focus is on acquiring, integrating and using experience and foreign market knowledge, and on the increasing commitment and resource allocation to the foreign markets. The logic is that the firm's behavior is reactive, driven by changes in internal and external conditions, not by a controlled development of strategy. In the I-model, the internationalization represents an innovation of the firm. The main reason for the slowness of the internationalization process is that the management of a firm operating in domestic markets is considered to be risk averse and lacks sufficient knowledge about foreign markets. The similarity in U- and I-models lies in the fact that they both assume the process to be a gradual, risk averse and reluctant process of adaptation to changes in a firm or its environment. They also assume barriers to internationalization, such as language and cultural differences as well as slow speeds of international communication and transportation, which have hindered the acquisition of information about foreign markets and increased the risks of internationalization.

The stage theories, as described above, see internationalization as a long gradual process, whereby firms are gradually getting commitment with foreign markets. The network perspective on internationalisation describes and analyses markets as networks of relationships amongst a number of players, e.g. suppliers, competitors, customers etc. (Johanson & Mattson, 1988). The basic underlying rationale is that enterprises require extensive knowledge of one another in order to do business. Uzzi (1996; 1997) considered networks as one of the most powerful assets that any individual can possess. The right network provides access to information, opportunities, power and to other networks. The effort required for creating such networked relationships and the competition between companies means that industrial networks are both stable and changing at the same time. According to the network model, a firm is directly and indirectly dependent on other firms: directly on those with which the firm has exchange relationships, and indirectly on those with which its direct counterparts have exchange relationships. The degree of internationalization of a production network is dependent on the number and strength of relationships between different national sections of the production network. Internationalization can take place in three ways: i) through international extension of new national networks, ii) through penetration of national networks abroad; iii) by integrating positions in different national networks, i.e. international integration. The network perspective claims that internationalization of markets means, that a production network can be considered international and that there are many strong relationships between national sections of the global production network.

The study of Coviello & Munro (1997) shows that the internationalization process of firms is influenced by the network made up of other firms (e.g. business partners, customers, distributors). They suggest that a firm's success in entering foreign markets is more dependent on its position in a network and relationships in current markets, than on market and cultural
characteristics. They state that the international market development is driven, facilitated and inhibited by a set of formal and informal network relationships. These relationships are important for recognizing threats and opportunities. These relationships will so influence the foreign market and entry mode selection, as well as product development and market diversification activities. The network model of internationalization states the value of different relationships for the success of international businesses. These relationships are important for the internationalization process of established firms.

Since the late eighties, the international business has been influenced by this new phenomenon called ‘globalization’. This new development created a new kind of firm, which internationalizes at a very early stage, sometimes at inception. In the literature these firms are referred to as ‘born globals’ (Knight & Cavusgil, 1996), ‘infant multinationals’ (Lindqvist, 1991) or ‘international new ventures’ (Oviatt & McDougall, 1994; McDougall et al., 1994). Established firms do not automatically have a competitive advantage over new firms. Since for example the easier communication by the internet, new firms can skip some stages of international business. This way they can create unique assets and competitive advantages over established firms. Also the homogenization of the distant markets is important. This helps everyone, including newcomers, to understand the conduct of international business easier (Oviatt & McDougall, 1994). These factors have changed the traditional ‘internationalization route’; ‘born globals’ instead enter all markets at the same time. When an organization does not do this simultaneously, its competitors will do so, which will endanger the competitive position and growth possibilities.

Oviatt & McDougall (1994) have developed the theory of ‘international new ventures (INV)’ and defined an international new venture as: ‘a business organization that, from inception, seeks to derive significant competitive advantage from the use of resources from and the sale of outputs in multiple countries’. The INV theory describes the existence of firms that from inception derive competitive advantages from serving the international marketplace. Four elements distinguish the subset of sustainable international new ventures from the set of all economic transactions. Internationalization of some transactions distinguishes transactions that take place within organizations from those that are governed by markets, alternative governance structure separates the subset of transactions constituting new ventures from those in established firms, foreign location advantage distinguishes the INV’s from the domestic new ventures and unique resources differentiate the subset of sustainable INV’s from those likely to be short-lived. The four basic elements explain the existence of the sustainable INV’s.

Based on the number of countries the INV enters and on the number of value chain activities it coordinates, different types of INV’s can be discerned (Oviatt & McDougall, 1994). The export/import start-up and the multinational market makers form the group of the ‘new international market makers’. They
represents a traditional type of firm, were they make their profit by transporting goods from their countries of origin to countries where demand exist. The export/import start-ups focus on serving a few countries with which the entrepreneur is familiar. Multinational traders serve several countries and are constantly scanning for trading opportunities. Geographically focused start-ups concentrate on specific needs found in a particular region, using foreign resources. They do more than just the coordination of the inbound and outbound logistics. They concentrate more on value chain activities like, technological development, human resources and production. The coordination of these activities is difficult to imitate, because it is socially complex or involves tacit knowledge. The advantage may be further protected by a close and exclusive network of alliances in the geographical area served. The global start-up is the most radical type of the INV, because it derives significant competitive advantages from extensive coordination among multiple organizational activities and from countries all over the world. They proactively act on opportunities to acquire resources and sell outputs wherever in the world they have the greatest value. As a reward they typically enjoy the most sustainable competitive advantages.

<table>
<thead>
<tr>
<th>Theory characteristics</th>
<th>Relevance for Innovative and manufacturing-based start-ups</th>
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<tbody>
<tr>
<td><strong>Stage theory</strong></td>
<td>• Gradual process</td>
</tr>
<tr>
<td>Johanson &amp; Vahlne (1977)</td>
<td>• Learning / committing resources</td>
</tr>
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<td></td>
<td>• Psychological distance</td>
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<tr>
<td><strong>Network theory</strong></td>
<td>• Relationships are important</td>
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<tr>
<td>Johanson &amp; Mattson (1988)</td>
<td>• Sharing knowledge</td>
</tr>
<tr>
<td><strong>Theory of INV’s</strong></td>
<td>• Alternative governance structure</td>
</tr>
<tr>
<td>Oviatt &amp; McDougall (1994)</td>
<td>• Foreign location advantage</td>
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<td></td>
<td>• Unique resources</td>
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<td></td>
<td>• Internationalization process faster through technological developments</td>
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<td></td>
<td>• Psychological distance still exists, but learning- and resource committing processes are improved</td>
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<td></td>
<td>• Networking is important for start-ups to discover new opportunities, to secure resources and to gain legitimacy</td>
</tr>
<tr>
<td></td>
<td>• Theory of INV’s describes the reasons and conditions under which the innovative start-ups go international</td>
</tr>
</tbody>
</table>

It is not easy to give a good definition of innovative start-ups either. Innovative start-ups are a subgroup of all start-up firms. An innovative start-up distinguishes itself by the newness of the product it delivers or the process by which the product is created and delivered (Tidd, Bessant & Pavitt, 2001). Several degrees of novelty exist in this, running from minor, incremental improvements right to radical changes which transform traditional routines. Sometimes the innovation is new for a particular firm or sector, but sometimes it is so radical that it is ‘new’ to the world. This study considers something as innovative when the product or process is “new” to the world. Innovative start-ups normally have a longer early development phase than normal starters, because they need time to develop a new product and/or process before they have their first market introduction.
The innovative entrepreneur mostly tries to market the new technology for a specific product-market combination. The direct demand from the market is mostly ignored in the first place. Roberts (1991) shows that the majority of business plans of innovative start-ups are primarily focused on the new innovative product, while there is little attention for strategy and marketing. For innovative start-ups the protection of the new technology is very important. A lot of capital is invested to develop this technology and the value of the firms is mainly based on it. There are two ways to protect this knowledge. The first way is to use legal protection instruments, like patents and trademarks. By patenting the exploitation of the technology by third parties can be forbidden or the firm can ask a fee for it. A patent for a new technology is very expensive and time-consuming, and the possible infringement costs are mostly high. The second option to protect the technology is to organize the operations in such a way that the secret knowledge stays in the company. The use of confidentiality agreements and the creation of tacit knowledge are examples of it.

Due to a lack of resources, knowledge and competencies in the field of purchase, production, logistics, marketing and sales, innovative start-ups often cooperate with other firms. Besides an idea and knowledge, capital is an essential factor for starting and building a new firm. For innovative start-ups the costs of developing a new technology/product are considerable. Banks are mostly not interested to invest in a new technology; for them it is very risky and the return on investment is insecure. Therefore in order to obtain capital, innovative start-ups have to utilize the investments of venture capitalists and business angels. The idea and screening phase is mostly financed by the founder(s)’ own capital. The capital provided by venture capitalists or business angels is mostly used for the development of the new product. Financing this development phase offers most problems, since there is no cashflow and the uncertainty is high. Also the market introduction is mostly financed by venture capital. When the risky development phase is completed successfully, the bank sometimes may play a role in this more predictable stage, or the now almost mature firm is able to finance further growth by its own cashflow.

This study focuses on innovative start-ups, that are manufacturing-based. These manufacturing-based firms face other problems with the entry of foreign markets compared with service-based firms. Previous research suggests that service firms tend to require substantially lower levels of financial investment than manufacturing firms (Brouthers & Brouthers, 2003). Services tend to be produced and delivered simultaneously and are more people-intensive than manufacturing firms. Manufacturing firms are more capital-intensive. Entry into a new country requires greater investment in production equipment, distribution facilities, warehouses with relatively low investment in people. In the few studies about entry mode selection of small firms there was a dominant position of software firms. These firms offer more intangible than traditional manufactured goods, and requires significant support and service to add value. The ease with which software can be
Distributed electronically effects the entry mode selection process. Software can be downloaded from the internet and is exchangeable around the world in seconds, without using expensive distribution facilities. This is compounded by the fact that development and marketing agreements between hardware vendors and software developers is an industry norm, so the industry is characterized by interfirm cooperation (Coviello and Munro, 1997). Instead of the software dominated firms in the previous studies, this study is focusing on innovative start-ups which produce tangible products who have invested a lot of time and money in research and development and where a substantial growth of the company is needed to earn back these investments. Because these innovative start-ups are mostly focusing on a niche market, the home market may not be big enough to earn back these investments rapidly (Lindqvist, 1991; Jolly, Alahuhta & Jeannet, 1992).

Because the entry mode selection is a important strategic decision for innovative and manufacturing-based start-ups, the general strategic decision-making processes of small firms will be examined. With the use of a strategic decision-making framework the entry mode selection will be studied. Eisenhardt & Zbaracki (1992) define strategic decisions as infrequent decisions made by the top leader of an organization that critically affect organizational health and survival. Most theories concerning the decision-making process make use of a framework, which comprises three components: the environment, the specific characteristics of the decision to be taken and the entrepreneur itself (Ivanova & Gibcus, 2003). These three independent variables are in constant interaction while following the path of the decision process. Ivanova & Gibcus (2003) have designed a framework in which the major elements constructing the decision-making process are interlinked. Here a change in any of the elements reflects on a change in the others. The entrepreneur will influence the parameters of the strategic decision process by the approach he is going to adopt (rational, emotional or intuitive). The strategic decision process will also affect the entrepreneur by bringing profit or loss to the business and will thus reshape the entrepreneurial knowledge and experience. The entrepreneur also influences the environment because of the creation and growth of the venture. In the opposite direction, the environment is constantly forwarding impulses for entrepreneurial actions (opportunities, threats, etc.) These environmental stimuli act as driving forces for the entrepreneur to make strategic decisions. The strategic decision process influences the environment by introducing innovative processes and products and so creates economic growth and market diversification. The environment, which is very turbulent, brings uncertainty and so shapes the decision process of firms. Firms therefore often make workable instead of optimal decisions (Ivanova & Gibcus, 2003).

| Differences between innovative service-based and manufacturing-based start-ups |
|-------------------------------------------------|-------------------------------------------------|
| **Manufacturing-based start-ups**              | **Service-based start-ups**                     |
| • Tangible products                           | • Intangible services                          |
| • Often patented                              | • Less patented                                |
| • Production and delivery separate            | • Production and delivery simultaneously       |
| • Capital intensive                           | • People intensive                             |

Because the entry mode selection is a important strategic decision for innovative and manufacturing-based start-ups, the general strategic decision-making processes of small firms will be examined. With the use of a strategic decision-making framework the entry mode selection will be studied. Eisenhardt & Zbaracki (1992) define strategic decisions as infrequent decisions made by the top leader of an organization that critically affect organizational health and survival. Most theories concerning the decision-making process make use of a framework, which comprises three components: the environment, the specific characteristics of the decision to be taken and the entrepreneur itself (Ivanova & Gibcus, 2003). These three independent variables are in constant interaction while following the path of the decision process. Ivanova & Gibcus (2003) have designed a framework in which the major elements constructing the decision-making process are interlinked. Here a change in any of the elements reflects on a change in the others. The entrepreneur will influence the parameters of the strategic decision process by the approach he is going to adopt (rational, emotional or intuitive). The strategic decision process will also affect the entrepreneur by bringing profit or loss to the business and will thus reshape the entrepreneurial knowledge and experience. The entrepreneur also influences the environment because of the creation and growth of the venture. In the opposite direction, the environment is constantly forwarding impulses for entrepreneurial actions (opportunities, threats, etc.) These environmental stimuli act as driving forces for the entrepreneur to make strategic decisions. The strategic decision process influences the environment by introducing innovative processes and products and so creates economic growth and market diversification. The environment, which is very turbulent, brings uncertainty and so shapes the decision process of firms. Firms therefore often make workable instead of optimal decisions (Ivanova & Gibcus, 2003).
Entry modes

There are different ways for a firm to enter a foreign market. The different ways for entering foreign markets are called “international entry modes”. Root (1994) sees a foreign entry mode as an international arrangement that makes the entry of a company’s products, technology, human skills, management, or other resources into a foreign country possible. Root (1994) recognises three different forms of entry modes: export entry modes, contractual entry modes and investment entry modes.

In the case of export entry modes a company’s final or intermediate product is manufactured outside the target country and is afterwards transferred to this country. Indirect exporting uses middlemen, who are located in the company’s own country and who actually do the exporting. A special form of indirect exporting is piggybacking. Here the company sells its goods abroad through the overseas distribution facilities of another producer. The two firms would normally have complementary, non-competitive products. Indirect exporting may be a good way for a firm to enter foreign markets for the first time. Indirect exporting demands little foreign market knowledge on the part of the firm, but for the same reason, it insulates the firm from foreign markets. A company that wants active penetration of international markets will look for direct export channels. In case of direct exporting the firm undertakes the export tasks itself and has to handle tasks like building contracts, handle documentation and organizing marketing. Root (1994) distinguishes two forms. Direct agent/distributor depends on target country middlemen to market the product of the exporter. Direct branch/subsidiary exporting depends on the company’s own operating units in the target country. This form of direct exporting requires an equity investment in marketing institutions located in the target country.

Contractual entry modes are long-term non-equity associations between a company and an entity in a foreign country that involves the transfer of technology or human skills from the former to the latter. These entry modes are primarily vehicles for the transfer of knowledge and skills and they may also create export opportunities (Root, 1994). The main difficulty with these kinds of entry modes is the protection and enforcement of intellectual property rights in the technology industry. Licensing is an appropriate entry mode if the firm has some type of proprietary asset, such as a patented product or process technology, trade mark or brand name, from which it wishes to benefit on an international scale without committing resources to international operations. In a license agreement a firm gives a licensee the right to utilize, for a defined period of time, the patented technology, trademark or brand name in return for payment or royalty fees. These fees are normally a percentage of sales covered by the agreement (Douglas & Graig, 1995). Root (1994) gives several reasons for a firm to use license agreements. One reason is simply to get incremental income on technology that has already been written off against domestic sales. Licensing may also be used to acquire the research output of a foreign company in return for that
of the domestic company. This is also known as ‘cross licensing’. Some companies have negotiated licensing contracts to protect their patents and trademarks in a foreign country against loss of non-use of against possible infringement.

International franchising is particularly attractive to a company, when it has a product that cannot be exported to a foreign target market, when the company does not want to invest in that country as a producer and when the production process of the company easily can be transferred to an independent party in the target country. Thus physical products whose manufacture requires substantial capital investment and/or high levels of managerial or technical competence are poor candidates for franchising. The same is true of service products that involve sophisticated skills, such as advertising, accounting, banking, insurance and management consulting. For those reasons international franchising is most popular in consumer service products that can be created with comparatively low levels of capital and skills (Root, 1994). The other contractual entry modes involve the transfer of services directly to foreign companies in return for monetary compensation (technical agreement, service contracts, management contract and turnkey contracts) or in return for products manufactured with those services (manufacture contracts and co-production agreements).

Investment entry modes involve ownership by an international company of manufacturing plants or other production units in the target country. In terms of the production stage, these subsidiaries may range from simple assembly plants, that depend entirely on imports of intermediate products from the parent companies, all the way to plants that undertake the full manufacturing of a product (Root, 1994). In terms of ownership and management control, foreign production affiliates may be classified as sole ventures with full ownership and control by the parent company or as a joint venture with ownership and control shared between the parent company and one or more local partners, who usually represent a local company. An international company may start a sole venture from scratch (new establishment) or by acquiring a local company (acquisition). New establishment (greenfield operation) involves the transfer of an entire enterprise to a target country. Local production may lower the costs of supplying foreign target markets in comparison with export entry, due to savings in transportation and custom duties and/or lower manufacturing costs resulting from less expensive local inputs of labor, raw material, energy etc. Local productions may also increase the availability of supply if quotas limit imports (Root, 1994). The success of an acquisition depends critically on the selection of the acquired company. A poor selection can have dramatic consequences. A joint venture entry takes place when an international firm shares the ownership of a company in a target country with local private or public interests. Most commonly an international firm agrees to share capital and other resources with a single local company. Depending on the equity share of the international company, joint ventures may be classified as majority, minority or 50-50 ventures.
According to the literature the impact of entry modes on the success of foreign operations is great (Anderson and Gatignon, 1986; Root, 1994; Hill et al., 1990; Lu, 2002). Young et al. (1989) found out five strategic dimensions on which the entry modes differ. These dimensions must be taken in consideration when making long-term strategic plans. The dimensions, which distinguish the entry modes, are: (i) Locus of control. This involves the extent to which a firm is willing to trade risk for obtaining more control over the entry mode. (ii) Resource commitment. This issue is strongly linked with the amount of control a firm wants to have. Substantial financial and management commitment will increase control, but will also increase risk. (iii) Resources transferred. Which resources need to be transferred to the entry mode? Is it just financial resources or does this entry mode ask for a substantial amount of management time and knowledge too? (iv) Motivation. The entry mode is a means to an end, therefore the choice of the entry mode should fit with the motive a firm has for entering a market. (v) Time, space and payment. Time limitations are specifically for those entry modes that are limited to the time of an arrangement, for example licensing is an agreement over time, while a sales office is often not time limited. Space limitation is the geographical area in which the agreement is valid, licensing and patent laws are for example limited to a specific country, while a distributor might sell in more than one country. Payment method involves the risk of how and when a firm will be able to gets its money from an intermediary in a foreign country. When a firm has chosen a foreign entry mode, it is very difficult to switch. The costs for changing an entry mode are commonly very high and time-consuming.

Many entry modes exist, but which entry mode is most optimal in which situation? For explaining the choice among exporting, licensing, joint venture, and sole venture modes, Dunning (1988, 1993) developed a framework (OLI-model). This framework includes firm-specific and market-specific factors and discusses the international organization should choose their most optimal entry mode on the basis of: superior ‘ownership advantages’, ‘location

<table>
<thead>
<tr>
<th>Entry mode</th>
<th>Degree of control</th>
<th>Degree of risk</th>
<th>Possible ROI</th>
<th>Resources commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export entry mode:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
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<tr>
<td>Indirect</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Contractual entry mode:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licensing</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Franchising</td>
<td>+/-</td>
<td>-</td>
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<td>+/-</td>
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<tr>
<td>Investment entry mode:</td>
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<td></td>
</tr>
<tr>
<td>New establishment</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Acquisition</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Joint-Venture</td>
<td>+/-</td>
<td>+</td>
<td>+/-</td>
<td>+</td>
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</table>

- = very low  - = low  +/- = average  + = high  ++ = very high
advantages’ and ‘internalization advantages. Hill, Hwang and Kim (1990) developed an entry mode decision framework for multinational corporations. In this framework they discuss the importance of entry mode decisions as a part of the whole global strategy of a company. The three distinct modes of entry (license, joint venture and greenfield operations) they use for their study are consistent with a different level of control, resource commitment and ‘dissemination’ risk. These determinants are important for the selection. In the framework of Hill, Hwang & Kim (1990) three variables influence the choice of the entry mode. Strategic variables influence the entry mode decision on the field of control that is needed to internationalize. Environmental variables influence the entry mode decision on the basis of resources, and, inally, transaction variables influence the entry mode decision through their influence on dissemination risks and on the level of control. It is essential to know which factors must be taken into account when choosing the right entry mode. Root (1994) gives a model containing these factors. He distinguishes external factors and internal factors, which are important for the right choice. The target country factors can be distinguished in market, environmental and production factors. The size of the target country is an important market factor. The size of the market must be large enough to earn back the entry mode investments. The competitive structure also has influence on the entry mode choice.

The quality, quantity and cost of raw materials, labor and energy in the target country as well as the quality and cost of the economic infrastructure have an important effect on the entry mode choice. These production factors determine the production cost of a product in the target country. When the production cost are lower in the home country exporting is more favorable. The political, economical and socio-cultural characteristics of a target country can influence the entry mode choice as well. Important factors are for example government policies and regulations, geographical distance, economical stability and the cultural distance. The market, production and environmental factors in the home country also influence a companies entry mode choice. For example high production costs in the home country relative to the target country encourage entry modes involving local production, such as licensing, contract manufacturing and investments.

The company factors can be distinguished in product and resource/commitment factors. The kind of product the firm wants to sell abroad has a great influence on the entry mode choice. Does the firm deliver a manufacturing-based product or a service? Also the degree of differentiation, adaptability and technological intensity is important. A very complicated product needs for example more control. The more abundant a companies resources in management, capital, technology, production and marketing skills, the more numerous are its entry mode options. Conversely, a company with limited resources is constrained to use entry modes that call for

<table>
<thead>
<tr>
<th>Entry mode</th>
<th>Control</th>
<th>Resource commitment</th>
<th>Dissemination risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licensing</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Joint Venturing</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
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only a small resource commitment. A company with little capital will for example not be able to use an investment entry mode. The studies in the previous section have analyzed the internal and external factors, which influence the entry mode decision. It can be concluded that choosing the most appropriate entry mode will involve trade-offs between different conflicting objectives. Young et al. (1989) examined different ways of the entry mode selection. They came up with three different selection approaches, namely the economic approach, the stage-of-development approach and the business-strategy approach.

The economic approach emphasizes rational behavior, with the costs and benefits of different entry modes being compared. The aim of it is to identify those options which maximize long-term profits. The degree of control available in different entry strategies is central to the economic approach since this determines both risk and the rate of return available. High control modes increase return, but also risk. Low control modes reduce resource commitment and thereby risk, but at the expense of return. According this approach choosing the most efficient entry mode involves rational trade-offs between control, resource commitment, risk and return. The stage-of-development approach relates the entry mode selection decision to the internationalization process. A shift towards entry strategies requiring greater resource commitment occurs over time with increasing internationalization of the firm. A firm will start with an entry mode which require less resources and will change it during the international growth process. The business-strategy approach emphasizes the pragmatic nature of decision-making in most organizations. Due to external uncertainty and the political nature of decision-making, organizations may adopt a ‘satisfying’ rather than a ‘rational-analytical’ approach to decision-making. Firms will have multiple objectives in expanding abroad and there will be conflicts between such objectives. Because of uncertainty and the need to combine conflicting objectives, it is extremely difficult to adopt a ‘rational-analytical’ approach and so firms often choose for a workable instead of an optimal solution.

The foreign entry mode selection of firms is researched by several studies. The focus here was on large established firms, which were already for a long time active in their own home market. Two empirical studies that investigate entry modes of small innovative firms in more detail stand out. Lindqvist (1991) reports that the preferred entry modes of the Swedish firms in her sample were direct exporting by own representatives or direct exporting by local representatives such as agents and distributors. These entry modes require less investments. However, she does not investigate the determinants that influence the choice of entry modes. Instead, she explores the propensity to use foreign subsidiaries. Here she finds no or weak relationships between entry mode choices and internal firm characteristics and industry structure. Bell (1995) finds out in his study about the international operations of small Irish, Finish and Norwegian software firms, that these firms prefer also the use of direct exporting. He reports that firms selling highly customized products mostly relied on own subsidiaries, whereas firms with standard
products were more likely to use sales intermediaries. Young et al. (1989) analyze the process of entry mode decision-making for small and young firms. They report that it is problematic for small and young firms to apply the rational-analytical approaches. Due to a lack of resources and information they are often forced to use the business-strategy approach and to choose for a workable instead of an optimal entry mode. These studies represent important first steps in explaining the entry mode decisions of innovative and manufacturing-based start-ups. However they also leave questions about the determinants of the choice of a particular entry mode largely undressed. They for example do not show exactly the factors which influence the entry mode selection of innovative and manufacturing-based start-ups most.

**Main findings current entry mode selection studies**

- There are a lot of conflicting factors which can influence the entry mode decision of firms
- Firms choose first their target country, after which they select the entry mode for that country
- Small and young firms are focusing on entry modes, which are less capital intensive
- Small and young firms make their entry mode decision pragmatic

**NOT: Reasons of innovative and manufacturing-based start-ups for selection a particular entry mode**

This research project is of an exploratory nature. The goal is to discover how the entry mode choices are made in reality and to explore which factors have a decisive influence on the entry mode selection. Explaining the different relations is important. In order to say something useful about the effect of the characteristics, a deeper insight is required into the relation between the influencing factors and the foreign entry mode choice. How is the selection made in practice and why this way? Case studies are conducted to find this out. According to Yin (2003) case study research has several advantages in answering these kind of how and why questions. The most important application of case study research is to explore and explain the causal links in real life interventions, which are to complex for other research methods. To answer the research questions, in-depth information was needed to describe and understand the rationales behind the entry mode selection of innovative start-ups. Case study research is an appropriate method, since it combines multiple data sources and allows researchers to study the different cases in-depth. Although the case study is the most optimal methodology to discover relations that would have been missed by using other forms of research methods, this contains also some disadvantages according some research investigators. The most important objection on case studies, is the lack of rigor, which implies that this method allows ambiguous evidence and biased view and that the outcomes are exposed to subjectivity from the researcher. Another concern about case study research is that they provide little basis for scientific generalization, since only a couple of cases are investigated. These
two objections can be avoided by paying proper attention to these aspects in the design of the case study (Yin, 2003).

In this study is chosen for a multiple case study, implying that the information for this study is gathered from more than one case firm. There are two main reasons for this. First, the goal of this research is to explore how Dutch innovative and manufacturing-based start-ups make their first entry mode decision. The evidence of multiple cases is therefore more suitable, since the influences of several firms can be compared with each other. In the second place, the overall study is regarded as being more robust, when a multiple case study approach is used (Yin, 2003). For gathering the information multiple data collection methods were used. By using different sources of information the power of the evidence increased (Yin, 2003). For getting a good profile of the company and its activities several sources were analyzed, like the website of the company, promotion materials, magazines and business plans. This information was used to make a description of the companies internationalization process, including the entry modes used. However, this data was not sufficient since it was sometimes incomplete and the rationales behind the internationalization decisions were underexposed. More in-depth information is needed to understand the rationales behind the entry mode selection decisions. To collect this information semi-structured interviews are conducted. According to Yin (2003) interviews have the advantage that they are targeted, since the focus is directly on the research topic. In this way you can gather direct the information you need. Another advantage of interviews is there insightfulness. The in-depth information provides perceived causal interferences. This is helpful to understand the rationales behind decisions. These interviews are held with those people in the company that are from inception familiar with the entry mode selection decision. Mostly they are the founders of the company, who also took the final decision. A semi-structured questionnaire was composed to guide the interview and then the founders were asked to give a short description of the company after which the specific research items were treated. These items are shown in the next section.

The research items which had to be collected during the interviews can be distinguished in the information which describes the entry mode selection process and the specific factors which influence this particular entry mode decision. The entry mode selection process is described with the use of the elements Ivanova & Gibcus (2003) apply in their strategic decision-making framework; it describes how the entry mode decision is made. The topics analyzed are: the entrepreneur, the environment, and the strategic decision process. For analyzing the influencing factors on the entry mode decision the factors of Root (1994) are used. The model of Root is chosen because it gave a wide range of influencing factors. With analyzing the influences of these factors an insight is given why decisions are made in a certain way. The factors analyzed are: internal company factors and external market factors. The foreign entry mode decision of innovative and manufacturing-based start-ups are influenced by the external market factors and the internal company
factors. In this strategic decision process there is an interaction between the entrepreneur’s personality, the environmental factors and the specific characteristics of the entry mode decision which had to be taken. Interaction between these items will lead to a final entry mode selection.

For this case study research three case study firms are selected. The selected firms had to comply to a set of criteria. For this reason the firms look a little bit similar, which make it more easy to control environmental and firm specific variations. This is important for drawing cross-case conclusions, as concluded earlier. The three firms were selected because of some criteria they met. First, the firms have the Netherlands as their home market. Second, the firms were all start-ups at the time of their first foreign market introduction. They went abroad within three years after their first market introduction and can be seen as international new ventures. Third, the firms have developed an innovative product, which means that the product is new to the world. Fourth, the firms are manufacturing-based. This means that they have developed and produced tangible products. Software-based and service-based firms were excluded in this research. Fifth, before their first foreign entry mode selection the firms are independent and not part of a bigger parent company. Last, the firms had their first foreign market introduction between 2000 and 2004, so macro economic influences are somewhat equal in the cases.

For the selection of the case firms the pocketbook Gestart in Delft (Loos & de Kort-Holgreve, 2002) was used. This pocketbook is a publication of the Business Service Centre of the Technical University of Delft and contains descriptions of innovative starters coming from this university. The start-ups in this pocketbook are founded in the region of Delft, so environmental characteristics are comparable. The firms used for this study and which are suitable according these criteria above are Ergodynamics BV, VPInstruments BV and Sunshower BV. The founders of these firms were willing to cooperate in this case study research. The founders interviewed were Mr. Dirk van Deursen from Ergodynamics, Mr. Pascal van Putten from VPInstruments and Mr. Oscar Meijer from Sunshower. The firms which meet the criteria discussed above and which are selected for this case study are

<table>
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<th>List of the interviews</th>
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<td>Interviewee</td>
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<td><strong>Ergodynamics</strong></td>
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<td><strong>VPInstruments</strong></td>
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<td><strong>Sunshower</strong></td>
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</table>

Ergodynamics, VPInstruments and Sunshower. In-depth interviews with founders of these innovative start-ups were used to answer the primary research question. The founders are interviewed, because they were involved
from inception and can explain the complete entry mode selection process. A list of the interviews is shown in the table depicted above. With the use of different analysis the similarities and differences between the cases will be examined. The choice for case studies as research methodology will be discussed in further detail in chapter six together with the selection of the specific case study firms.

Case studies

The purpose of the empirical research is to investigate how innovative and manufacturing-based start-ups deal with the choices in their foreign market entry in real life. The firms used for the case study, namely Ergodynamics, VPIInstruments and Sunshower, are active in complete different industries and sell different products. These differences are important for increasing the external validity. Besides this, there are also a lot of similarities. The firms are all start-ups which develop and manufacture innovative products and are established in the Netherlands. This conformity leads to similarities in decision-making among these firms and make it more easy to draw cross-case conclusions. The information for these descriptions were mainly gathered during in-depth interviews with the founders of the selected innovative and manufacturing-based start-ups. These descriptions provide an overview of the firm's characteristics, growth and internationalization process and the chosen entry mode. Quotes of interviewees are used to clarify the case descriptions. Before giving the complete descriptions, in the table below some general information of the case firms is summarized.

<table>
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<th>General information about the case firms</th>
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<tr>
<td><strong>Ergodynamics BV</strong></td>
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<tr>
<td>Year of foundation: 1997</td>
</tr>
<tr>
<td>Product: Ergonomic chairseat</td>
</tr>
<tr>
<td>First market introduction: 2000</td>
</tr>
<tr>
<td>First foreign market introduction: 2000</td>
</tr>
<tr>
<td>Number of employees: 5</td>
</tr>
<tr>
<td>Revenue (last year): € 400.000 - € 600.000</td>
</tr>
<tr>
<td>% of the revenue from abroad: 25 %</td>
</tr>
<tr>
<td>Licensing partners / Distributors: <a href="http://www.ergodynamics.com">www.ergodynamics.com</a></td>
</tr>
<tr>
<td>Internet site: <a href="http://www.ergodynamics.com">www.ergodynamics.com</a></td>
</tr>
<tr>
<td><strong>VPIInstruments BV</strong></td>
</tr>
<tr>
<td>Year of foundation: 1998</td>
</tr>
<tr>
<td>Product: Silicon-based flowmeter</td>
</tr>
<tr>
<td>First market introduction: 2002</td>
</tr>
<tr>
<td>First foreign market introduction: 2002</td>
</tr>
<tr>
<td>Number of employees: 2</td>
</tr>
<tr>
<td>Revenue (last year): € 200.000 - € 300.000</td>
</tr>
<tr>
<td>% of the revenue from abroad: 80 %</td>
</tr>
<tr>
<td>Licensing partners / Distributors: <a href="http://www.vpinstruments.com">www.vpinstruments.com</a></td>
</tr>
<tr>
<td>Internet site: <a href="http://www.vpinstruments.com">www.vpinstruments.com</a></td>
</tr>
<tr>
<td><strong>Sunshower BV</strong></td>
</tr>
<tr>
<td>Year of foundation: 2001</td>
</tr>
<tr>
<td>Product: Solarium in shower</td>
</tr>
<tr>
<td>First market introduction: 2004</td>
</tr>
<tr>
<td>First foreign market introduction: 2004</td>
</tr>
<tr>
<td>Number of employees: 6</td>
</tr>
<tr>
<td>Revenue (last year): € 700.000 - € 800.000</td>
</tr>
<tr>
<td>% of the revenue from abroad: 25 %</td>
</tr>
<tr>
<td>Licensing partners / Distributors: <a href="http://www.sunshowerEurope.com">www.sunshowerEurope.com</a></td>
</tr>
<tr>
<td>Internet site: <a href="http://www.sunshowerEurope.com">www.sunshowerEurope.com</a></td>
</tr>
</tbody>
</table>

Ergodynamics BV

Ergodynamics is founded in 1997 by Mr. Leo van Deursen and his son Mr. Dirk van Deursen. Ergodynamics has extensive expertise on the field of orthopedic science, ergonomics and biomechanics. Mr. Leo van Deursen is a doctor and orthopedic specialist and has developed with his son a new
technology to reduce backpain. This RCPM-technology (Rotary Continuous Passive Motion) is a patented invention which make it for Ergodynamics possible to make sitting more healthy. With the use of a barely noticeable rotation of a chairseat the backpain during sitting can be reduced. This technology can be implemented in for example office chairs, luxury fauteuils, car chairs and specific ergonomic chairs. Further has Ergodynamics developed the Torzio pillow which can be used in every chair separately. Ergodynamics is focusing on the specialized chair branch, which is a niche market. For the end consumer the use of this RCPM-based products is not service intensive. With a simple instruction the product can be installed and used. Unless it was a very new concept of sitting, the market acceptance was quite good. The people with backpain were willing to use the products since it was really helping reducing their pain. The firm is daily managed by Mr. Dirk van Deursen and another general manager. Further they have four other employees. These people are organizing sales, administrative and logistic processes. For incidental work they sometimes hire freelance personnel. The firm is for a part financed by some venture capitalists. For investing in Ergodynamics these venture capitalists own a percentage of the shares. The venture capitalists have an advisable role in strategic decision-making processes, but the final decisions are made by the two managing directors.

After the founding in 1997 the products are developed and a financing structure is arranged. For the market introduction of the RCPM-technology, Ergodynamics wanted to use licensing as their market entry mode, as well for the Netherlands as for foreign markets. A foreign introduction was needed, since the Dutch market was too small to earn back the investments. They had a very strong patent and they expected to grow very fast by the use of big and experienced licensing partners. They have developed the technology, but also the technical parts which have to be used during the manufacturing of RCPM-based chairs. For the office market they closed a license agreement with Grabert GmbH from Germany, which is a big manufacturer of office chairs. This firm has an international distribution channel, so the RCPM-technology was sold international from the first market introduction in 2000. For the consumer market Ergodynamics contracted Leolux. Leolux is a large manufacturer of furniture and has developed a fauteuil with the RCPM-technology. Also Leolux has a broad distribution channel in Europe and North-America. They use agents and dealers to sell their furniture. For the ergonomic market Ergodynamics closed a license agreement with Fitform. This firm is a specialist on the field of ergonomic chairs and has a distribution channel in western Europe. Also the automotive industry was contracted. They close a license agreement with Isringhausen GmbH & Co, which is the market leader in the truck chair industry. Since the use of these licensing partners, Ergodynamics immediately had a very wide distribution channel. These partners have picked-up the products of Ergodynamics in their assortments.

Unless the wide and experienced distribution channels of the licensees, high sales quantities of RCPM-based products stayed out. The products were sold,
but not the quantities Ergodynamics expected. The products of the licensees are still for sale, but the focus of Ergodynamics changed. In reaction to the disappointed sales of the licensees, Ergodynamics developed the Torzio. This is an ergonomic pillow implemented with the RCPM-technology on which people with backpain can sit. This pillow is very compact and can be used on every chair. The Torzio is manufactured in Asia under supervision of Ergodynamics and the distribution and marketing of the Torzio is now also coordinated by Ergodynamics. The Torzio had its first market introduction in 2004 and is sold by three different distribution channels. The first focus is on the medical channel; Van Deursen: ‘The licensees were manufacturers in the regular office and home furniture and were not able to convince people with backpain to buy a curing chair. Medical specialists, like physiotherapists and doctors are more able to do this, so for the Torzio we use specialized distributors in the medical sector.’ Physiotherapists and doctors have a lot of patients with backpain and so they can recommend the Torzio. Another channel is the specialized office supply channel. Here people with backpain can, on recommendation of a medical officer of the firm they work, get the Torzio. The last channel which is directly focusing on the consumer market is direct selling by the internet. Ergodynamics has developed its own internetsite on which the Torzio can be ordered. Because Ergodynamics can not sell the Torzio all by themselves they make use of specialized distribution partners. The Torzio is now exported to Belgium, Scandinavia, Malaysia and Singapore were Ergodynamics has specialized distribution partners. For the future export to Germany, Great-Britain, Japan and North-America is expected.

Ergodynamics first used license agreements to enter foreign market and to sell the RCPM-technology. The licensees were all large firms with a relative broad range of products. Ergodynamics closed license agreements with these firms, because they thought it was a cheap and fast way to sell a lot of RCPM-based products all over the world. Ergodynamics only had to develop the technical parts for the RCPM-technology. The implementation and design of the complete RCPM-based chairs was done by the licensees. Unless these good conditions the cooperation's between Ergodynamics and the licensees were insufficient. The main reason for this was the lack of priority the licensees had to sell the products. The RCPM-based products were only a little part of the complete assortment the licensees sell. So there was not a real drive to sell the new product; Van Deursen: ‘In relation to the large multinational licensees we had very little power and control. For the sales of the Torzio we want to cooperate with smaller distributors and create a more equal relation in which our vote counts.’ Unfortunately this drive is needed to sell a product which uses a new technology. The customers are unfamiliar with the new technology and are therefore a little bit skeptic. To overcome this, it is important to explain the advantages of the product carefully. Another reason for the insufficient sales was that the licensees were not specialized in selling ergonomic and curing products and so they did not have the right contacts with the target group.
For the distribution of the Torzio Ergodynamics, used another entry mode. They wanted to have more control and sell directly to the customers with backpain. They focused on the medical channels, ergonomic office suppliers and the direct sales of the internet. They first entered the Dutch market with the Torzio. Shortly after that they also entered Belgium, Scandinavia, Malaysia and Singapore; Van Deursen: “We first wanted to enter European countries, but we could not ignore the demand from Asia.” For arranging this export Ergodynamics used distributors. The main reasons for entering foreign countries by distributors is the high speed of entering, the relative low cost and the specific marketing infrastructure of the medical channel. This medical branch is organized differently in every country. The physiotherapists, hospitals and pharmacists have in each country a different organizational structure. Therefore it was important to cooperate with local distributors which know the market well. Ergodynamics did not develop a special entry mode strategy. The meetings with the current distributors were mainly accidental. The contacts with the distributors in Belgium and Scandinavia were made on trade fairs. The contacts with the distributors in Malaysia and Singapore were made during coincidental meetings in Asia. The current distributors have a good network in the foreign countries, but the main reason for Ergodynamics to cooperate with these distribution partners was their enthusiasm and believe in the product.

VPIInstruments BV

VPIInstruments is founded in 1998 by Mr. Pascal van Putten together with his father and brother. VPIInstruments develops and produces mass flowmeters for compressed air and gasses, based on silicon sensors technology. These silicon sensors are patented and make it possible to measure the consumption of gasses within pipelines very accurately. These measurements can for example be used for optimizing the energy consumption of machines. VPIInstruments sells its products to industrial suppliers of compressors, which use the flowmeters in their products and services, and to distributors of measuring equipment. Incidentally flowmeters are directly sold to industrial companies. The market of specialized gas flowmeters is a niche market. Worldwide there are about five small competitors which produce comparable flowmeters. The flowmeters are delivered including instruction manual. For very specialized measurements extra support from VPIInstruments is sometimes needed. Further it is needed to calibrate the flowmeters once a time. The flowmeters are sent to VPIInstruments where they are calibrated on the unique and expensive calibration machine. This machine is too expensive for small distributors. After some adjustments the flowmeters are returned.

The firm is managed by Mr. Pascal van Putten. His father and brother are not daily involved in the company, but they are still one of the main investors. Further there are cooperation’s with the Technical University of Delft and Shell. They support some researches, but they are not shareholders. VPIInstruments have two employees. They are mainly involved in technical
developments and calibration activities. They also organize the outsourcing activities. Some technical developments are outsourced to freelance engineers. Also some marketing activities are outsourced. The main strategic decisions are made by Mr. Pascal van Putten in consult with his father and brother.

The real start of VPInstruments was in 1998. They first focused on R&D activities and developed the silicon-based flowmeters. This basic development project was finished in 2002 and the flowmeters were good enough to sell. Because VPInstruments did not have financial means to build an own manufacturing plant, they outsourced the production of the flowmeter parts. They only organize some assembling activities and the whole calibration of the flowmeters. The first market introduction was in 2002. In this year VPInstruments sold its flowmeters to a large manufacturer of compressors. This multinational firm implemented the flowmeters in their products and used them for their services. Because this firm operates worldwide, the flowmeters of VPInstruments are now used in more than 50 countries. VPInstruments has to sell its products abroad, because the Dutch market is too small to earn back the development costs. The firm became an international venture from inception.

After this large contract VPInstruments kept going on with R&D activities to optimize the flowmeters and to develop new measurement possibilities. Since 2002 VPInstruments is trying to sell its products by using foreign distributors of measuring equipment. There are some contacts with distributors in the Netherlands and Germany. The distributors take up the flowmeters of VPInstruments in their assortments and sell them to their industrial customers. These distributorship agreements are not exclusive so VPInstruments has the right to sell directly to end users in the region where the local distributor is active. Since the sales of the current distributors is not sufficient and because VPInstruments wants to grow, they are looking for distributors worldwide. A freelance export manager is appointed to search for new distributors and to enlarge the distribution network. VPInstruments is primarily focusing on neighboring countries, but if distributors from more distant countries are enthusiastic and have the right requirements they can also become a distributor. VPInstruments also started its own promotion campaign; Van Putten: “Once, the sales of the distributors we had was insufficient and so we decided to sell directly to some end consumers. We started an European promotion campaign and contacted some end consumers ourselves. We think that good distributors can do it better, but at that moment we did not had the time to search for good partners. It was an emergency scenario to generate cash quickly.” They are for example active on tradeshows and are advertising in European magazines, which are specialized on the measurement sector. The purpose of this promotion campaign is to contact new distributors and to meet new consumers. Sales requests from end consumer to VPInstruments are replied so they are now also selling directly to end consumers abroad.
The first entry mode used was direct exporting. Here the flowmeters were exported directly to the large foreign compressor supplier. The first contact with this supplier was arranged during the R&D-phase between 1998 and 2001. This firm was looking for specialized flowmeters which could measure more accurate. This first customer was very important to generate cash in the start-up phase. For further growth VPInstruments wanted to build a distribution network with foreign distributors. VPInstruments has chosen for this entry mode, because the use of distributors is most common in comparable sectors and with comparable products; Van Putten: ‘In our sector the use of foreign distributors is the most common way for small firms to distribute their products. Why should we do it differently?’ Further it is fast and relative cheap to work with distributors. A distributor had to fulfill some requirements. They must have a distribution network and enough technical skills to sell the flowmeters. Further it is very important that they are enthusiastic and that they are willing to invest in local marketing activities; Van Putten: ‘The enthusiasm of the distributor is the most important selection criteria. When the distributor believes in the product he put effort in it to make it a success’. VPInstruments worked with different distributors. The cooperation’s were not all very successful. Sometimes the effort of a distributor to sell the flowmeters was minimal and did not meet the expectations of VPInstruments.

Because the sales of the current distributors not come up to the expectations, VPInstruments also tries to sell directly to end consumers. By starting the promotion campaign they created their own market demand. With direct exporting they now also serve end consumers worldwide. They sell flowmeters directly to European countries but for example also to China, Iran, India and the United States. In contradiction to the use of distributors VPInstruments has more control, but direct exporting without using distributors although required more effort. This direct sales generates financial means in a short period of time, whereas the benefits of new distributors take a longer period of time. Because of the financial situation it was needed to generate sales immediately. On the long term the distributors become more important. VPInstruments does not have a very specific strategic plan in which the entry strategies are explained. The most decisions are made on an ad-hoc basis.

Sunshower

Sunshower is founded in 2001 by Mr. Merijn Wegdam and Mr. Oscar Meijer. Before starting the firm they were both students at the Technical University of Delft. They have developed the Sunshower, which is a solarium integrated in a shower cabin. With the use of the Sunshower, people can combine tanning and showering and so save time. Sunshower has a patent on the installation technique of the solarium. With this technique it is possible to implement a solarium in a shower cabin according European safety regulations. Electricity and ventilation are separated from the bathroom and therefore the Sunshower is a completely safe product. The Sunshower can be implemented
in new or renovated bathrooms. The installation of the solarium is done by certified installers and the lamps have to be checked every year by a certified service team.

Sunshower is focusing on people who like trendy and fashionable products and who find quality time and their appearance important. Sunshower delivers to the consumer market, but they also deliver their products to other firms. Here you have to think about hotels, beauty centers, fitness clubs etc. They serve the business-to-consumer as well the business-to-business market. Before entering the market they cooperated with a marketing and communication agency to develop a marketing plan. This was important to get an own style. The product acceptance was quite well, since the communication to the consumer was well prepared and because the target group consists of people who like new things.

The firm is daily managed by the two founders. Mr. Merijn Wegdam is general manager and Mr. Oscar Meijer is commercial manager. The firm is financed by a British Business Angel, who invested in the firm for 50% of the shares. The Business Angel also appoints for two days a week an experienced interim manager who guides the management team; Meijer: ‘For the continuation and growth of the firm it is now important to make a professional step and to formalize our decision-making process. The interim manager is guiding us through this growth phase.’ Strategic decisions are made in accordance with all the shareholders. Six employees are working for Sunshower. They are involved in activities like R&D, marketing, logistics and administration. They have a R&D department, because they want to become a large player on the field of designed sanitary. Therefore this department develops innovative and trendy sanitary products. The production of the Sunshower is outsourced to a social workshop in the Netherlands. They were involved in the R&D phase and are now producing and assembling the product.

After the establishment Sunshower first developed the complete product. The main development process was finished in 2003. In 2004 they had their first market introduction in the Netherlands. A contract was closed with the Bad and Body chain stores and so directly 90 sanitary stores in the Netherlands were selling the Sunshower. In 2004 Sunshower also had their first foreign market introduction. In England Sunshower contracted a sales agent which they met on a trade faire. This agent represents Sunshower and is active in the sanitary branch. He also approaches new dealers in England and organizes marketing activities. Further he is responsible for building a service network in England; Meijer: ‘We needed local partners to arrange and coordinate the installation and safety checks of the Sunshower. It is impossible for us to coordinate this kind of services out of the Netherlands.’ In the same year Sunshower also contracted an agent in Ireland, which organizes the same activities as his English colleague. Working with agents, the invoice and distribution of the product is arranged by Sunshower in the Netherlands.
In Germany, Belgium and France Sunshower is working with distributors. These distributors have several large sanitary stores in which they sell the Sunshower. Sunshower delivers promotion materials, sales trainings and technical support. Sales, distribution, installation, service and invoice are tasks of the distributors. Sunshower now also arrange some activities in Russia, Poland, Switzerland and Turkey. In these countries potential agents and distributors are trying to build a distribution and service network. If they are able to fulfill the requirements of Sunshower agreements are closed. For the future Sunshower is trying to establish a joint venture in the United States. First contacts with potential partners are already organized. Sunshower wanted to go international immediately, because it was important to grow fast and to build a solid dealer network. The Dutch market was not large enough to fulfill the desire to be a big player in the luxury sanitary branch. Before entering the first market Sunshower did not had an extensive strategic plan. They had a business plan, but it changed very often because of changing market demands and different partner possibilities; Meijer: “Because of the different partner possibilities and the changing market demand, the strategic plan was not usable anymore. The first entry decisions were made on intuition. We had a good feeling about the agent in England and so we closed an agreement.” Now the structure of Sunshower is formed, strategic planning become more important.

England was the first foreign market Sunshower entered. They entered this country because it is a large market and because it was the home market of the financier. The British Business Angel already had good contacts in England and therefore this country was more accessible. Sunshower entered this first foreign market by an agent. Sunshower used an agent in England because it is a relative cheap and fast way to build up a dealer network. It also fits with the way the English sanitary branch is organized. The sanitary branch is build up with relative small and independent sanitary stores, so an active agent has to contact the stores separately. An agent is more suitable for this than a distributor. Because the newness of the product Sunshower wanted to have control and therefore they organized the distribution and invoice itself. There were no language barriers and the British Business Angel knew the market well so this could be organized out of the Netherlands. The results of the cooperation with the English agent were good and so Sunshower contracted an Irish agent to represent the firm in Ireland too.

The luxury sanitary branch in Belgium, France and Germany is organized differently. Here the market is build-up with large stores which provide a whole area. Direct contact with these distributors is more successful. They know the market and have already a network. These large stores are also able to deliver the desired service. The distribution and invoice is done by these distributors and they have their own installation and service department. This in contradiction to the relative small stores in Great-Britain; Meijer: The composition of the luxury sanitary branch is different in every country. In for example France you have just a couple of big players per region. We can contact these distributors directly and do not need an agent.
In England the market is built up with small and independent players and therefore we need a local representative to contact the stores separately. The use of distributors is a fast and cheap way for entering these markets. Because of some language barriers it is better that the distribution and invoice is handled by a local party. Sunshower has selected these countries because of the short geographical distance, but the partnerships were often determined by coincidental meetings.

Sunshower also tries to build up a network in Russia, Poland, Switzerland and Turkey: Meijer: ‘It is not efficient to go to one target country and to focus only on that country. You miss a lot of fantastic opportunities if you do so.’ They have contacts with agents and distributors in these countries. These people try to organize a dealer network. Sunshower did not select these countries itself. The accidental meetings with these potential partners largely determined the geographical expansion. These potential partners were selected on some criteria. They had to have contacts in the luxury sanitary branch and must have the technical and commercial skills to build up a good dealer network. Besides these criteria the most important thing is that they are enthusiastic and believe in the new product. According to Sunshower this enthusiasm is needed for successful market introductions.

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<th>Motive for internationalization</th>
<th>Ergodynamics</th>
<th>VP Instruments</th>
<th>Sunshower</th>
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<tbody>
<tr>
<td>Too small home market</td>
<td>Too small home market</td>
<td>Too small home market / To build a large dealer network specialized on luxury sanitary</td>
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<th>Entry modes used</th>
<th>Licensing partners / Distributors</th>
<th>Direct export / Distributors</th>
<th>Agents / Distributors</th>
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<tr>
<th>Countries entered</th>
<th>Worldwide by licensees / Belgium, Scandinavia, Malaysia and Singapore by distributors</th>
<th>Worldwide by direct export / Germany by distributors</th>
<th>England, Ireland by agents / France, Belgium, Germany by distributors / Other European countries by agents and distributors</th>
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<tr>
<th>Service intensity product</th>
<th>With simple instruction product can be installed and used</th>
<th>With instruction product can be installed and used / Calibration needed every year</th>
<th>Product installed by certified installers / Security check needed every year</th>
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<table>
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<tr>
<th>Experienced problems</th>
<th>Little priority of licensees / Not optimal sales channel of licensees / Lack of capital</th>
<th>Little priority of distributors / Lack of capital, personnel and international experience</th>
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</thead>
</table>

Also the United States is a potential market Sunshower wants to serve. Because of the product responsibility-system Sunshower do not want to service this country by exporting from the Netherlands. European assurance companies do not assure possible claims arising after product failures. To overcome this problem Sunshower wants to establish an independent joint venture in the future. Due to the financial situation of Sunshower it is not possible to establish a joint venture at the moment, but contacts with potential partners are already made. An investment entry mode in the United States might be possible in a couple of years. Sunshower also considered the
use of license agreements for going international, but due to the lack of control with this entry mode they preferred to use agents and distributors.

In the table above a summary is given of the main choices and characteristics of the firms concerning their entry mode selection, their motives for going abroad, and the countries entered. Additionally, the service intensity of the products and the problems the firms experienced during the internationalization process is highlighted as well.

**Cross-case analysis**

The founders of the case firms are all engineers who had their education at the Technical University of Delft. They were real entrepreneurs and saw an opportunity to build up their own company. Mostly they were also active in little businesses during their study. The entrepreneurs see an opportunity and are willing to take risks. They are willing to make the first investments and expect that the new product has enough potential to make profit on the long-term. Other conditions which are needed to build-up a firm successfully, like capital, market information and trained personnel, are filled in later on. The start of the firm, but also other strategic-decisions like the entry mode decisions are mainly based on intuitive and pro-active behavior. Because of the technical education the founders were from inception more focused on the technology instead of the market demand. The first years after the establishment of the firms, the technical development of the new technology was the main issue. Marketing and sales had relative little attention at that time. The firms all developed a simple business plan during the start-up phase, but due to other priorities, adjustments to these plans were not made. The value of it so decreased, since the plans were not up-to-date. Since the firms are growing now, strategic planning become more important. The British business angel of Sunshower appointed an interim manager to guide the founders of the firm in the strategic internationalization process. Also Ergodynamics appointed a general manager after the first market introductions. This manager is installed on advice of the venture capitalist and is focusing on overall strategic planning.

Environmental market forces also influence the entry mode selection process of the innovative and manufacturing-based start-ups. The case study firms are all focusing on niche markets with their own market channels. Ergodynamics is focusing on the specialized ergonomic market, VPInstruments wants to serve the market of specialized gas measurement equipment and Sunshower is aiming on luxury sanitary branches. The entry mode selection process of the case firms was initiated, because of the need for international expansion. All entrepreneurs had from inception the believe that the firms could only survive when there was international expansion. The Dutch market was just too small to earn back the development costs. For Sunshower there was also a strategic motive to grow fast, since they wanted to become a large player on the designed and luxury sanitary market. Fast
growth is needed to prevent that competitors fill in this market gap. After international expansion had been put on the agenda, the firms looked which entry modes were possible to use. The firms did not investigate the possibilities very accurate. They primarily searched for common entry modes which were already used in the market sector. A thorough analysis of other possibilities was not made and none of the case firms developed a real entry strategy. Selection of the final entry mode out of the possible ones, was not a real rational process too. There were no clear selection criteria, so the final decision was made very pragmatic. The availability of potential partners plays an important role in this process. Other factors which affect this decision are internal company factors and factors which are related to the entry mode decision itself, like partner and country selection.

According to the theory the case firms have limited resources to internationalise. They invested a lot of time and money in their product development and neglected the other resources, like management, production and marketing. Root (1994) argues that the more abundant the resources in capital, management, technology, production and marketing the more numerous its entry mode options. Young firms with limited resources have less entry mode options. The innovative and manufacturing-based start-ups are confronted with limited resources and so their entry mode options were also limited. The lack of capital is the most important influencing factor. This factor, however is influenced by the other resource factors. A lack of management, marketing and production experience leads to a lack of financial means. Due to their limited financial resources all case study firms were forced to use entry modes with less financial commitment needs. Using investment modes or establishing own foreign export subsidiaries were no realistic possibilities. The firms had to choose for indirect exporting, exporting by foreign agents/distributors, direct sales to end consumers or contractual entry modes.

The lack of resources does not only influence the entry mode possibilities as described above, they also affect the final selection. Relative little attention is paid to this process, not only since the founders are technology driven but also because there is not enough capital and in-house knowledge to make a thorough analysis of the alternatives. Lack of information results in the fact that the firms imitate the practices of similar firms in their line of business. The investment of the case firms in R&D was normally higher as estimated and so financial means by sales and cash flow were needed to survive. The need for a financial injection is for the firms an important reason to make the final entry mode choice quickly. The choice is therefore mainly based on coincidental entry possibilities. Service intensity of the product is also a factor which affects the entry mode choice. The higher the service degree, the higher the importance of a good organization. Sunshower could not organize the service by their own, so they had to cooperate with a local partner. The choice for using agents and distributors was mainly based on this. VPIInstruments also has a product which needs a yearly service. The difference with Sunshower is that this calibration process has to take place in
the Netherlands. Local partners are not yet able to organize this service. The customer sends the flowmeter to the Netherlands and after the calibration it is returned. The service aspect just influences the entry mode choice if the service takes place in the target country.

Innovative and manufacturing-based start-ups deliver an innovative product, which is new to the market and risky from the viewpoint of the buyer. In the beginning it is needed to put effort in the sales activities and to convince the new customers. To overcome this problem the case firms want to have control over the sales process. Due to the limited entry mode possibilities a starting firm has, the partner selection is very important in this. Ergodynamics has developed a patented technology, which is easily to produce. This makes it possible to cooperate with a licensing partner. Ergodynamics made use of licensing partners and so the existence of a patent influenced the entry mode choice of this firm. It gives an extra entry mode possibility, which is relative cheap. For the other two firms the patent did not play a role in the entry mode selection process.

The most influencing factors on the entry mode selection of innovative and manufacturing-based start-ups are the internal company factors. From the target market factors, the foreign marketing infrastructure is most important. The organisation of the target market is important since the case firms often imitate similar firms, which serve the same branch. A reason for Sunshower to use an agent in England was the dispersed structure of the luxury sanitary branch. They think that an agent is more able to build a dealer network in this country. For Ergodynamics a different target group approach was the reason to switch the focus from licensees in the chair sector to distributors in the medical sector. The market structure so influences the entry mode choice. The size of the target market did not play a role in the entry mode decision. Equity modes are preferred in markets with a high sales potential, but since it is not possible for innovative and manufacturing-based firms to invest in these modes, they do not take it in consideration. The size still influences the country selection.

Production factors in the target country are not important for the case firms, since the first target countries are situated in Europe as well. Production costs are approximately the same in these neighbouring countries, so reduction of these costs is not really possible here. The cultural distance between the home market and target market did not play an important role in the entry mode decision. When there is a small cultural distance, the use of equity modes are preferred. These modes are not achievable for innovative and manufacturing-based start-ups and so they are forced to use entry modes, which are also suitable for entering countries with a great cultural distance. Since innovative and manufacturing-based start-ups often cooperate with foreign intermediaries, which know the target market well, the cultural differences are not an issue. For Sunshower the legal barriers in the United States might influence the entry mode choice in the future. An independent firm establishment, like for example a joint venture, is needed because of the
product responsibility in that country (e.g. high claims for compensation arising from product failures). Sunshower does not have the financial means at the moment to establish an independent firm, and these legal barriers are for Sunshower a reason not to enter the United States at the moment.

Besides the composition of the market structure in the target market, the other factors do not play a large role in the entry mode selection. Because of the internal company effects, the target market factors are not very relevant any more. These target market factors mostly determine the choice between equity and non-equity modes. The equity modes are not achievable for the start-ups, so the affects of the target market factors are marginal in the start-up phase. The factors still play a role in the country selection. The home market factors do not play an important role in the entry mode selection. The small size of the Dutch market is a reason for international expansion, but does not directly influence the entry mode choice of the innovative and manufacturing-based start-ups. The case firms also make use of export subsidies, but this does not really influence the entry mode choice.

Also the selection of the possible partner influences the final entry mode choice. The case firms apply a business-strategy approach and do not develop an entry strategy. Since there was not an entry strategy, the requirements the partners had to meet were not clear either. The case firms make short lists with soft criteria, which prospective partners have to meet. After the development phase a fast growth is needed to generate capital. The need for this was sometimes so high, that a coincidental partner possibility determined the entry mode selection. Sunshower for example is trying the build a dealer network in Turkey and Switzerland. These countries might be more suitable for entering by the use of foreign distributors. Sunshower decides to make use of agents instead of distributors, because of the coincidental meetings with potential partners in these countries. The agents Sunshower met were enthusiastic and wanted immediately invest in a promotion campaign. The agents did not fulfill the requirements exactly, but because of their enthusiasm and willingness to invest, they convinced Sunshower to do business with them.

Due to the lack of time and money, the partner choice is often made on feelings instead of good assumptions. This leads often to partnerships which are not optimal. The main problem which occurs is that the distributor or agent is not able to obtain sustainable advantages out of the product sales. The fact that these intermediaries often have several products in their portfolio and that the innovative products are relatively expensive and require an intensive selling process, leads to hardly motivated intermediaries. When advantages of intermediaries decrease the partnerships will never been a success. The first choice of Ergodynamics to use licensing partners was not optimal. The partners did not put enough effort in the sales of the product and were not able to contact the right target group. The results were not satisfying. Also VPInstruments has a bad experience with a distribution partner. This distributor sold many different products and did not put
substantial effort in the sales of the flowmeters of VPInstruments. Therefore they decided to stop the relationship. The partner choice is very dependent on the personal network of the firm. Exhibition of the product on trade fairs is for innovative and manufacturing-based firms an important way for meeting potential partners. Here first contacts are made with people in the sector. A vast professional network will increase the partner possibilities.

At the time of the first market introduction, the case firms had defined their target market very globally. Ergodynamics is aiming on people with backpain who sits a lot, whereas VPInstruments wants to sell their product to industrial companies which use gas flowmeters to optimize their machines. Sunshower is focusing on trendy and fashionable people to introduce their new way of douching and tanning. The target groups of the case firms are all forming niche markets, which in every developed country exist. The start-up firms are not able to serve the entire world immediately and that is why they first have to made a country selection. Cultural and geographical factors mostly determine that these firms first focus on neighboring countries. The sequence in which the countries are entered is mostly not very important, since the countries are all potential markets.

Besides some firm specific preferences, the coincidental partner possibility is decisive in the determination of the country choice. For the international expansion of innovative and manufacturing-based firms cooperation with good foreign partners is often the key to success and so the choice for a partner plays an important role in the country selection. Sunshower preferred to enter England first, since the business angel already had good contacts there. The choice for entering Russia, Poland, Switzerland and Turkey is mainly determined by coincidental partner possibilities. These agents / distributors were very enthusiastic thus Sunshower gave them the chance to prove themselves. The market entry of for example Singapore and Malaysia by Ergodynamics is also a result of an accidental partner meeting. Ergodynamics sources the manufacturing of the Torzio out in Asia. During a business trip to that region Mr. Van Deursen coincidentally contacted potential distributors. Distribution relationships with these people so determine the entry of Singapore and Malaysia. A main reason for the fact that innovative and manufacturing-based start-ups do not focus on one specific country, and realize that they have to be successful in several countries to survive.

**Conclusions**

Innovative and manufacturing-based start-ups have invested a lot of time and money in the development of new products and in order to recover these investments they have to grow fast. The main motive for innovative and manufacturing-based start-ups to go abroad is the small size of the home market. The high development cost and the focus on a niche market make it necessary to enter foreign countries from inception. Innovative and manufacturing-based start-ups choose for entry modes which are less capital
intensive. Our case firms are using direct sales channels, foreign subsidiaries or licensing partners; equity modes like, joint ventures, green field investments or acquisitions are not used. This study conforms the literature that it is problematic for innovative and manufacturing-based start-ups to apply rational-analytical approaches to their entry mode selection decision; instead this decision is often made more pragmatically. However, an accurate description of what this entry mode selection process looks like for innovative and manufacturing-based start-ups, is not given by the current theories on international entrepreneurship.

The general entry mode selection theories state that a firm first chooses the specific target country and that they subsequently select the best entry mode. After this decision the firm searches for a partner to cooperate with if necessary. The findings of this study do not support the process description given by general entry mode selection theories. The entry mode selection process of innovative and manufacturing-based start-ups is better described by the interaction between the country selection, the entry mode choice and the selected partner. These different decisions influence each other simultaneously and determine the foreign market introductions. The founders of innovative and manufacturing-based firms are mostly engineers. They are driven by opportunities instead of available resources and are primarily focused on the technology development. The strategic and marketing issues are generally underestimated. After the development phase a fast foreign market introduction is often appropriate and therefore this leads to intuitive, opportunistic and proactive behaviour. The lack of resources is another factor which influences the process. Not only the lack of international experience and strategic priority of the founder determines the process. Also the lack of financial means and information has its influence on the process. Because of these shortcomings a thorough internationalisation analysis is not possible. During the development phase the firms have less income, which often leads to critical situations. Sometimes the need for a financial injection is so high, that the first entry mode possibility is utilized to gain capital as soon as possible. The choice is made on the basis of pressing circumstances or emergency factors instead of good opportunities. The possibility to cooperate with a partner is thereby often decisive. The potential partners are often met on trade fairs or by accidental meetings, which are elicited because of the firm’s network. Because of the restrictions caused by internal company factors, like the lack of resources and the uncertainty of the product, target and home market factors are less relevant. Overall it can be concluded that the entry mode choices of innovative and manufacturing-based start-ups are mainly determined by restrictions instead of opportunities.

The choice of an entry mode for innovative and manufacturing-based start-ups can be improved with the findings of this paper. An important process in the foreign entry of innovative and manufacturing-based start-ups is the foreign partner selection. This selection is underestimated by these firms, which often leads to unsatisfied partnerships. The firms have to put more effort in the partner selection. It is important to have a clear characterization
of a potential partner in an early stage. Clear criteria are important to filter the potential partners and to focus on the interesting ones. To contact new potential partners the network of the firm is important. Active networking must become a point of interest in the entire organization. If it is not possible to purchase own stands during trade fairs due to lack of financial means, visiting them is still valuable to create new contacts.

This paper also has some limitations. The first limitation is the limited generalisability of the findings. This is caused by the relative low number of case study firms which are investigated. In order to find significant results more case firms should have to be researched. This study only focuses on innovative and manufacturing-based start-ups so generalizing the findings to other kind of industries is not directly possible. Other starting firms in for example the service industry can not make use of the findings, without making some adjustments. For the future, researching the entry mode selection process of innovative service firms could be useful in order to provide insights in the similarities and differences between the manufacturing-based and the servicing-based industry.

References

INFORMATION AND COMMUNICATION TECHNOLOGY
IN HIGH-TECH SMALL AND MEDIUM-SIZED
ENTERPRISES. A MANAGEMENT PERSPECTIVE

Dipl.-Kfm. Daniel Kathan
University of Siegen
Chair of Business Administration, in particular Media Management
Hölderlinstrasse 3
57068 Siegen
Germany

Phone: +49-(0)271-7402905
Fax: +49-(0)271-7402904
Email: daniel.kathan@uni-siegen.de
Abstract

The adoption and usage of Information and Communication Technology (ICT) is a strongly discussed issue. In particular the interorganizational adoption is recognized as an important issue. While big companies have most of their processes with partners integrated by now, there is still a lot of work to do within the small and medium-sized companies. One of the hypothesis in this context is that high-tech small and medium-sized enterprises (HT-SME) are leading in comparison to average SME concerning their intraorganizational and interorganizational adoption of ICT.

The goals of the study are a description of the state-of-the-art of the (interorganizational) adoption of ICT in high-tech SME. A further goal is the discussion of elements of a management framework which allows handling ICT in HT-SME in a more efficient and effective way.

The methodology used for analyzing the interorganizational adoption of ICT in the high-tech small and medium-sized enterprises as well as for developing the above stated framework is case study based.

Interesting intermediate data became visible. It seems that even the small and medium-sized high-tech companies do not use highly sophisticated information and communication technology for interorganizational cooperations. Further interesting results are that hardly any of the companies interviewed develop their employees for using ICT in intra- and interorganizational settings. Another interesting result is that HT-SME hardly evaluate the spending in intra- and interorganizational ICT.
Outline

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1. Introduction/Problem

Electronic Business is nowadays in the business life as well as in the private life nearly omnipresent. Looking at the speed of diffusion of internet technology you will realize that no other medium, maybe even no other technology, was distributed in such a fast manner. Electronic Business does not only have in practice but also in scientific discussion a high significance. Yet the „hype“ and the euphoria of the years 1999 and 2000 proceeded to a much more rational kind of observation.

In the past five to seven years a lot has been written about Electronic Business. The novelty and especialness of this study is to look at the context of Information and Communication Technology (ICT) in High-Tech Small and Medium-Sized Enterprises (HT-SME). And there, more specific, towards the intra- and interorganizational adoption and usage of ICT from diverse perspectives which are business administration, information management/information systems as well as media sciences.

While big companies recognized most chances of the adoption of internet technology, small and medium-sized enterprises have been long very sceptical towards this adoption (Vincenti 2002). At many places they speak about a very hesitant adoption of internet technology in SMEs (Wirtz 2000, 27; Hughes/Golden/Powell 2003; Cruickshank/McLeod 2004, 546-548; Kayser 2005). SME primarily use email applications and simple webpages but with the adoption of complex online applications they are slow. The barrier of „complexity“ by the adoption and usage of innovations in general was first identified by Rogers (1995) and confirmed in the context of SME and E-Business (Kendall et al. 2001).

Broadly it gets argued that through the strategic adoption of internet technology/information technology organizations (small and big ones) reach their goals more easily, become more competitive and sustainable management can be assured (Ndubisi 2003, 23). Information as well as information processing and communication technologies become also more and more important by developing new business fields (Pietsch 2003, 5). Moreover, Weiber points out that the adoption of ICT and the usage of electronic applications offer new market opportunities and thus new potentials to increase revenues (2000, 10). Above all, ICT offers the possibility to generate higher process efficiency and higher output with less employees (Wirtz 2001, 10).

While big companies have most of their processes with partners integrated by now, there is still a lot to do within the SME. This is important if you consider how many SME there are in Europe. In average there are 99,8% of all companies SME and 65,7% of all employees work in SME. One of the hypothesis in this context is that HT-SME are leading in comparison to „average SME“ concerning their intraorganizational and interorganizational adoption of ICT. Due to their high rate of inventions and innovations, small and medium-sized enterprises in the high-tech area are an engine for growth of economies and therefore worthwhile to consider.

General conditions HT-SME need to cope with are the following. Nowadays the environment in which SME and in particular HT-SME need to assert themself is more competitive, faster and more cost oriented then ever. There is a high number of external influences HT-SME need to cope with. These influences are the increasing globalization, the boosting deregulation, the enhanced cost pressure, the raised expectations of the customers as well as the reduction of the product life cycles. But also the continuously increasing digitalization and the
convergence of media are circumstances which lead to a more and more complex management of high-tech SME.

In this context it is questionable whether HT-SME are able to be competitive without the interorganizational adoption of ICT. Is it the pure adoption that brings competitive advantages or are there further circumstances which have to be taken into account like for example the efficient and effective adoption of them. In other words, is it just the use of technology or does it depend on how one uses them? Therefore one needs to take into account considerations from the strategic management and other functions from business administration. Furthermore there might be a possibility that the „average SME“ learn from the HT-SME and their experiences of intra- and interorganizational ICT adoption.

2. Goals and Motivation

One goal of the study is a description of the state-of-the-art of the (interorganizational) adoption of ICT in high-tech SME. Who uses intra- and interorganizational ICT, who doesn’t? If they use or don’t use ICT interorganizationally and why do they behave in a certain way? Are there any differences between enterprises in the US and in Germany? How will the intra- and interorganizational usage of ICT develop in the future? A further goal is to discuss elements of a management framework which allows handling ICT in HT-SME in a more efficient and effective way.

The motivation for this study is based on several reasons: First, there exist several confirmations that adequate research in the context of ICT and high-tech industries hardly exist (e.g. Trettin 2005; Wareham/Zheng/Straub 2005). One of the very few articles is: „The Strategic Impact of Internet Technology in Biotechnology and Pharmaceutical Firms“ (Sala-zar/Hackney/Howells 2003). Second, the State Ministry of Economic Affairs and Employment in Germany in cooperation with the European Institute of International Cooperations (EIIW) and the „Fraunhoferinstitut“ support in their study „Internetwirtschaft 2010“ the estimation that there exists a lack of internet oriented research concerning SME’s (Welfens 2005). Exactly the same was also identified on some other place (Di-xon/Thompson/McAllister 2002). Third, management of interorganizational processes remain on top of the research agenda (see for example meta-analysis from Wareham/Zheng/Straub 2005). McAfee also suggests that the construction of electronic partnerships becomes one of the most important IT-based competitive battlegrounds in the coming years (2005). Furthermore there is evidence that until now the usage of ICT by formulating electronic based cooperations is hardly analysed (Rothgang/Trettin 2005). Fourth, as already stated in the introduction, due to the inventions and innovations, the high-tech industry is an engine for growth of economies. There is a tendency visible that the huge overall impact of high-tech will increase in the next years. Fifth, there hardly exists any study in this context concerning comparisions between different areas or countries.

3. Classification in the Context of Scientific Research

Influenced by the interdisciplinary character of the present topic there are several scientific disciplines which have to be taken into account. From a business administration point of view strategic management, innovation and technology management, human resources, organization and controlling are areas of central importance. From a more technical point of view com-
puter sciences, information systems and information management have to be considered. Moreover media sciences are also very important for explaining these patterns, which is often neglected in the traditional literature about Electronic Business.

At the end of the nineties first interdisciplinary studies were conducted in the area of information management and organization research (Picot/Reichwald/Wigand 2003; Reichwald et al. 2000). Nevertheless there is still a lot to do on the interface between business administration and computer sciences, information systems and information management respectively. Partially the latter ignore findings made in the area of business administration and models business software, which gets obtruded to companies without any adaptation. Hence an integrated model with all the relevant aspects of this context is necessary.

4. Methodology

The methodology used for analyzing the intra- and interorganizational adoption of ICT in the high-tech small and medium-sized enterprises as well as for developing the above stated framework is case study based (see Eisenhardt 1989; Gassmann 1999; Meyer 2003; Yin 2003). In 2005 and 2006 several interviews with CEO’s, CIO’s and people from business development in high-tech companies in Germany and in the US were conducted. The interviews were semi-structured and partially done by phone, partially done personally and took about one hour in average. The focus thereby is on the following four industries. The biotechnology, nanotechnology, software industry as well as the medical device sector. In Germany companies which are a member of [www.nano-map.de](http://www.nano-map.de) were contacted. This is an initiative from the Federal Ministry of Education and Research. In the US, or rather in Boston and the region around, companies were contacted over several councils and directories [Massachusetts High Technology Council (MHTC), Massachusetts Software Council, Massachusetts Biotech Industry Directory, Massachusetts Medical Device Industry Council (MassMEDIC)]. Until now half of the planned interviews are completed. Meaning there are still more to come to stabilize the first results.

Although Eisenhardt develops her framework for generating theories it will be used in this context rather to test and check existing hypotheses and theories (Eisenhardt 1989; for Eisenhardt’s framework see Chart 1). The advantages with inductive case study research are the ones given below. Case study research is very useful by looking at highly complex and less structured objects. Moreover different data collection methods for gathering and understanding the interrelationships can be integrated, it gives answers to „how“- and „why“-questions, the explorative gathering of findings gets supported and influencing factors can be considered.

A further reason supporting qualitative research is the following. Lee recognizes scientific research as a social constructed reality and therefore scientific knowledge as human creation like every other form of knowledge as well (2001, 240). Consequently social systems, organizations, customers and social practices are a social constructed reality. Here the connection to the qualitative methods becomes clear: the generation of information is a social process and qualitative methods are more appropriate than quantitative methods to approach social processes and their complexity (Trauth 2001, 275). Besides there are also some disadvantages of case study research like the problem that statistical representativeness can’t be obtained or the existence of implicit hypotheses due to the influence of previous knowledge or insularity. After the presentation and analysis of the individual case studies it is necessary to conduct a
cross-case analysis. This is important to find similarities and differences of the cases on the basis of several dimensions. With this procedure the probability increases to find all the results which are in the data.

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<tr>
<th>Step</th>
<th>Activity</th>
<th>Reason</th>
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<tr>
<td>1. Getting Started</td>
<td>Definition of research question, possibly prior constructs, neither theory nor hypotheses</td>
<td>Focuses efforts, provides better grounding of construct measures, retains theoretical flexibility</td>
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<tr>
<td>2. Selecting Cases</td>
<td>Specified population, theoretical, not random, sampling</td>
<td>Constrains extraneous variation and sharpens external validity, focuses efforts on theoretically useful cases - i.e., those that replicate or extend theory by filling conceptual categories</td>
</tr>
<tr>
<td>3. Crafting Instruments and Protocols</td>
<td>Multiple data collection methods, multiple investigators</td>
<td>Strengthens grounding of theory by triangulation of evidence, synergistic view of evidence, fosters divergent perspectives and strengthens grounding</td>
</tr>
<tr>
<td>4. Entering the Field</td>
<td>Cross-case data collection and analysis, including field notes, flexible and opportunistic data collection methods</td>
<td>Speeds analyses and reveals helpful adjustments to data collection</td>
</tr>
<tr>
<td>5. Analysing Data</td>
<td>Write-case analysis, cross-case pattern search using divergent techniques</td>
<td>Gains familiarity with data and preliminary theory generation, forces investigators to look beyond initial impressions and see evidence through multiple lenses</td>
</tr>
<tr>
<td>6. Shaping Hypotheses</td>
<td>Iterative tabulation of evidence for each construct, replication, not sampling, logic across cases, search evidence for &quot;art&quot; behind relationships</td>
<td>Sharpens construct definition validity and measurability, confirms, extends, and sharpens theory, builds internal validity</td>
</tr>
<tr>
<td>7. Enfolding Literature</td>
<td>Comparison with conflicting literature, comparison with similar literature</td>
<td>Builds internal validity, raises theoretical level and sharpens construct definitions, sharpens generalizability, improves construct definition, and raises theoretical level</td>
</tr>
<tr>
<td>8. Reaching Closure</td>
<td>Theoretical saturation when possible</td>
<td>Ends process when marginal improvement becomes small</td>
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Chart 1: Process of case study research (Eisenhardt 1989, 533)

5. ICT and High-Tech

In the area of ICT there exist quite a few different terms and definitions depending on the research discipline as well as on the time of publication. Here ICT is considered as media ranging from telephone to Internet as well as the systems behind it. For the support of information- and communication systems technical devices like telephone, fax or computer as well as non-technical devices like paper or files can be used (Gabriel et al. 2002, 104). Although the main focus here lies on devices and possibilities based on the Internet technology. The technological possibilities/means of interorganizational cooperations also increase steadily. But due to the diffusion in nearly all areas of companies the complexity increases as well. While EDI – a form of interorganizational system – has been around for about 30 years, it has failed to gain acceptance in general and in particular among SME. The Internet – a newer form of IOS – has been in just two years adopted faster than EDI in the previous 20 years (Hughes/Golden/Powell 2003, 277). A lot is based on EDI but important developments in this area are Web Services, Groupwaresystems and Computer Mediated Communication (CMC).

To define small and medium-sized enterprises (SME) you will find about 200 different definitions. They are mostly divided in a quantitative (e.g. employees, turnover) and a qualitative (e.g. unity of property and responsibility or limited access to capital) section. The problem with the definition of SME is, that a lot of economic, social and even psychological characteristics have to be taken into account. In 2003 the European Commission (EC) developed a new definition and uses it since January 2005 (European Commission 2003). The EC considers number of employees and financial thresholds like turnover and total assets. Moreover
there exist different possibilities to distinguish high-tech small and medium-sized enterprises. On the one hand they have to fulfill the above stated criteria on the other hand the below stated aspects in regard to high-tech. Partly this is based on Jassawalla/Sashittal (1998):

First one can analyze to what extent technology and what kind of it will be needed in the production process. Second there is the possibility to look at the product. Concerning the product you would look towards the features and the technology integrated in the product. One can also look at the high rates of product obsolescence as an indicator for a high-tech company. Third one can look at the industries. Most people would consider microelectronics, computer industry, biotechnology, nanotechnology, rocket industry and others of the technology fusion fields (concerning the technology fusion fields see Sannemann 2000, 148; v. Waldkirch & Koruna 1998) as high-tech. The fourth indicator of high-tech industries might be their R&D-expenditures. The German Ministry for Education and Research for example suggests that a company would be high-tech if it spent 3,5-8,5% of turnover in R&D. And they would call a company spending more than 8,5% on turnover into R&D „Spitzentechnologie“. This is something like „advanced technology“ or „leading edge technology“. The problem with these figures, primarily in the context of small and medium-sized enterprises is, that many of these small and medium-sized companies just were founded. Therefore they won’t generate any turnover. And a life-cycle bias is imaginable as well. Because it is possible that the companies spend early at the life-cycle more into R&D than later. So these figures are only partially senseful due to this and due to the fact that expenses and profits get mixed up. Which leads us directly to another, the fifth possibility to define high-tech small and medium-sized companies. One could use the R&D-expenditures in relation to the total cost. If these expenditures are at least 10% then one could say they are high-tech companies (Klocke 2004, 7). The sixth possibility might be how many people in relation to the overall employment do they have in the R&D area or R&D department (see chart 2).

![Chart 2: Possibilities to define high-tech enterprises](image-url)

### 6. Strategic Aspects and Management Aspects of the Study

The presumption of the strategic management, irrespective of the approach (resource-based/market-based), is that companies acting strategic are more successful than companies who don’t. Strategic management is therefore occupied with the planning and implementation of corporate strategies (Welge/AI-Laham 2003, 3). Small and medium-sized companies get quite often organized and managed centrally. Problematic in this context is that business managers or owners hardly do have any time to think about strategic issues due to a high burden of operational tasks (Haake 2002, 234; Vincenti 2002, 34). For this reason these kind of considerations will be undertaken for E-Business and the interorganizational adoption of ICT, which is becoming more and more important in the overall strategic context. Due to specific
conditions and a specific environment this is not always possible thus there one will find at least in an abstract way some typologies and guidelines for decision making.

The benefits of ICT for gaining competitive advantages you will find in general in two different aspects (Weiber 2000, 16). First, the adoption of ICT leads to a direct improvement of the corporate value-added process. Second, nowadays information is the steering force in competition. Already in 1952 Hayek pointed out that competition has to be interpreted as a process of information processing. Later it has been also observed, that the foundation for competitive advantages lies in information advantages (Kirzner 1978). Out of this the meaning of a strategic, that means methodic, procedure for Electronic Business can be derived. The accelerated processing of intra- and interorganizational processes and information can potentially lead to competitive advantages.

Why will the strategic aspect of Electronic Business in high-tech small and medium-sized enterprises be discussed in this study? There are several reasons for doing so. The two most important are the following. First, in general a strategy represents a corridor of activities which under normal circumstances a company tries to follow. This is also true in the field of ICT and can be adopted to it. Second, Gartner Group (1999) found out that the following reasons are the main causes for the failure of E-Business projects. On the one hand companies try to convert premature business models into reality. On the other hand there exist immense problems by implementing and realising planned e-business projects. Moreover, mistakes in the strategy are a further cause of failure. A high level of attention will be dedicated in the study to this last point.

Due to the increased cooperation and collaboration of companies, issues like network management and Supply Chain Management became and are still becoming more and more important. A characteristic for networks is the high complexity which results out of a large number of connected entities. Even the customers (in this study primarily on a b-to-b level) are becoming in the development phase more and more integrated (virtual customer integration). Advantages due to ICT lie in the high interactivity over distance and time. Moreover nowadays it is possible to visualize physical product- and service components close to reality (Dahan/Hauser 2002, 333; Gassman/von Zedtwitz 2003, 244).

All of this leads to an increased necessity of an effective and efficient management of interorganizational ICT. In this context theories like for example game theory, transaction cost theory, resource-oriented approach or interaction oriented network theory play an important role. It is also important to mention that cooperations of companies can happen on different levels which affects directly the adoption of ICT. One can distinguish the level of the company, of single departments and of course of individuals. The direction of the cooperation can be horizontal, vertical (that would equal the Supply Chain Management) and diagonal. But there are many more possibilities to characterize cooperations and in particular networks.

Like stated above it is possible due to ICT to gain competitive advantages. Nowadays the problem in doing so is that ICT is to a high extent commoditized. That means that literally every company can buy itself all kind of ICT. Meaning if a company is generating competitive advantages due to the adoption of ICT this advantage normally won’t last long. Exactly that long until another enterprise copies the adoption of ICT in that specific way. According to several scientists (Clemons/Row 1987; Mata/Fuerst/Barney 1995; Dehning/Stratopoulus 2003) ICT itself offers no possibilities to gain sustained competitive advantages. Due to the fact that the technology is not heterogeneously distributed across competing enterprises or not
imperfectly mobile, ICT may only lead to competitive parity or temporary competitive advantages. Moreover they argue that the sustained competitive advantages are lying rather in the management of ICT. This is the reason why in this study the management of ICT will be analysed in detail. For the coherences of the above stated aspects see chart 3.

![Chart 3: Resource-based model of competitive advantages (Mata/Fuerst/Barney 1995)](image)

A further reason for analyzing the management of ICT is the result of a meta-study of 72 studies concerning the interrelationship of ICT and economic success (Pfeifer 2003). In 81% of the studies there is a positive relationship between ICT and economic success. In the studies without the positive relationship, critical factors are organizational change and HR change (Pfeifer 2003). Also others identified the importance of the organizational and HR perspective (Fischer 2002; Dedrick/Gurbaxani/Kraemer 2003; McAfee 2005). The organizational and HR perspective are two out of five variables of the above stated management framework. The third variable is the strategic aspect of ICT. For successful adoption of ICT there has to be a strategic direction as well as management support (Dixon/Thompson/McAllister 2002; Ross/Weill 2004). The fourth variable is the assessment of ICT spending and adoption. IT-Investment appraisal is an important part in the decision-making process (Irani/Love 2002). Last but not least the environment has to be taken into account and needs to be analyzed.

7. Intermediate Data and First Results

Through the case studies intermediate data and first results, interesting for practitioners and scientists, became visible. In the following some of the results of a first cross-case analysis will be listed in an eclectic manner:

At first there will be a short overview of ICT related matters of HT-SME. Many of the enterprises interviewed do have an IT-department. But the department only consists of 1 person and sometimes this person has to accomplish other tasks (non-IT related tasks) as well. From the resource-side it is difficult to select, implement and most important run a highly complex intra- and interorganizational ICT solution. No question there is also the possibility of outsourcing. But this is a question of financial resources and in the context of these high-tech companies even more important of privacy and of business secrets. Often the „one-person-IT-department“ is totally overloaded and tasks of the IT department get outsourced. Due to the above stated reasons this are mostly easy and not very strategic tasks like for example the design and maintenance of websites.
In the companies itself employees are mostly connected via an intranet. Furthermore many of HT-SME do have a virtual private network (VPN). In a truly private network the company owns all the wires and nobody else can use them. In the VPN also public networks get used. With the VPN employees are able to access the companies information from external sites.

Cooperations happen in the context of HT-SME primarily on the research and development side as well as on the marketing side. Here small and medium-sized companies try for example to do research with large enterprises or want to use their established distribution channels. In general one can use several theoretical explanations to argue why organizations act together. There you will find justifications from exchange theory, contingency theory and organizational ecology as well as transaction cost theory (Alexander 1995, 7-14).

Concerning the first goal, meaning the adoption of interorganizational ICT, it seems that small and medium-sized high-tech companies use unsophisticated applications for supporting interorganizational cooperations. Sophisticated information and communication technology they hardly use for interorganizational cooperations. For many companies, which were interviewed in this study until today, the most complex tools they use are applications for web conferencing, video conferencing and online meeting services (e.g. „WebEx“, „GoToMeeting“). The utilization of these tools offers a lot of possibilities in the context of interorganizational settings. Features like slide presentations, application sharing, web co-browsing, text messaging and files sharing can improve and optimize interorganizational cooperations. However these applications are far from a real integrated interorganizational system.

The five most important barriers with the intercompany employment of ICT, here in particular of web services, are insufficient standardization, complex integration in IT infrastructure, small spreading at customers, complex integration in existing processes and other security problems (Prokein/Faupel 2006, 5-6). In the context of high-tech small and medium-sized enterprises there were statements like from a business (business model) point of view it is not necessary to be connected. It is only necessary to integrate with other companies when it is suitable. This is an important aspect before discussing about the adoption of interorganizational ICT. Is it really necessary to use any sophisticated, complex and modern technology? Or is it totally sufficient to handle the intercompany cooperation with telephone and email? A very important and big issue is in this context the topic of security and privacy. Companies experienced for example problems with intercompany systems due to too restrictive firewalls. Furthermore if you take into account the data handled by pharmaceutical companies it is understandable how important the security aspect in these companies is. But also reasons like complex integration, inadequate quality of the interorganizational systems as well as the argument that costs exceed utility.

Further interesting results concerning the second goal, the management framework, are the following. Here a diverse picture became obvious. Some of the interviewee mentioned that a management framework for managing intra- and interorganizational adoption of ICT would be helpful. In contrast others argued it is not necessary at all. And some said they think it would be very helpful in companies with more than 100 employees and for people not very experienced with these issues. Also interviewees mentioned that in the area of security it would make sense to have certain policies.

In the following some management issues will be presented. Questionable is if these results would be similar with having the above stated management framework. Very interesting is
that hardly any of the companies interviewed do develop their employees for using ICT in-house and in interorganizational settings. A lot of potential might be unexploited due to the lack of education in ICT related fields. Most HT-SME in the study argue that their employees don’t need any special training concerning ICT because they have adequate knowledge about ICT. Only employees in one of the interviewed high-tech small and medium-sized enterprises receive educational training in the context of ICT via telephone as well as online.

Interesting as well are the actions companies take or don’t take to narrow down the misuse of ICT. Here all interviewees emphasise the importance of trust between the management and the employees. Trust as a prerequisite between parties in interorganizational virtual collaborations has been already identified (Hossain/Wigand 2004). It seems that in the context of ICT the intraorganizational trust plays also a key role. But here differences become explicit. While some companies emphasise the self-policing aspect others restrict the access to websites which are not relevant for working purposes. In some of the interviewed HT-SME employees are allowed to download for example music; in others employees were fired due to that kind of behavior.

A further first result in regard to the management framework is that companies do hardly evaluate or assess the spending of intra- and interorganizational ICT. Except one company all HT-SME in the study categorical excluded doing an assessment of ICT-Investments although this provides management with a lot of relevant information. ICT-Investment appraisal helps companies in the decision-making process and companies are able to gain higher profits. The only company in the study assessing ICT-Investments is doing so by trying to calculate the ROI of these investments. The reason for not doing an assessment is in the opinion of the interviewees in most companies a lack of human resources as well as a low level of ICT spendings. Asked about the next steps concerning ICT many HT-SME plan further developments. This ranges from further employments to the implementation of an ERP-system.

8. Conclusion

Due to space restrictions a lot of problems couldn’t be discussed in this paper but are part of the present study. For example the integration of ICT in the interorganizational business processes of HT-SME, the appliance of media-richness-theory in the context of complex products and services and the differences between German and US HT-SME in the interorganizational adoption of ICT.

In this stage of the study a lot of fundamentals have been discussed like ICT and high-tech in general. Furthermore it has been pointed out that the efficient and effective management of ICT leads to sustained competitive advantages. Also it became obvious that HT-SME exploit only in certain circumstances sophisticated ICT. A management framework for managing ICT should consider elements like strategy, organization, HR, controlling as well as the environment.

Some first insights and empirical evidence has been put forward to highlight the adoption of ICT from a management perspective. But we need further evidence and analysis of the adoption and usage of intra- and interorganizational ICT in high-tech small and medium-sized enterprises.
9. Bibliography


Wirtz, B. W.: Der deutsche Mittelstand verpasst den Anschluss im E-Commerce. In: FAZ, No. 184, 10.08.2000, p. 27.
Innovation, in particular ICT-enabled innovation, often failed as a result of a mismatch between technology developers and end users in the market and industry. Therefore the Dutch government established public private partnerships, so called Leading Technological Institutes, to bridge the gap between science and market. In this paper we focus on one of these institutes, Telematica Instituut which addresses ICT-enabled innovation.

The institute’s innovation model combines virtues of the Open Innovation model advocated by Chesbrough and the Mode 2 innovation model proposed by Nowotny and colleagues. Increasingly the institute engages SMEs in its research projects as innovation agents. The Integrated Log Family initiative serves as an interesting example. This open source project engages SMEs in the healthcare and sports into content management solutions. This application domain normally suffers from a “technology push” image and collaboration and co-development around open source help to break down those walls.

Leading Technology Institutes, and other public private innovation initiatives alike, must shift focus from centralised toward networked system integration, involving SMEs as innovation agents. Open source projects can be an effective instrument to attract SMEs and to realise impact through open innovation.
I. Introduction

Innovation, in particular ICT-enabled innovation in the past often lacked an effective introduction. Too often, there was a mismatch between technology development and actual demands and preferences of suppliers and/or end users. ICT-enabled innovation however remains an important factor for many technological developments, crucial for a viable high level (service) economic, relevant for social welfare and a challenging research field academics in natural sciences, technology and social sciences.

Dutch government, alike foreign governments, therefore stimulates companies and scientific institutes to enhance cooperation with respect to ICT; to involve business in scientifically grounded approaches and have academics triggered by business’ and societal problems.

A lot has been achieved in terms of new networks and dedicated research programmes. However, in ICT-enabled innovation it has shown difficult to create results beyond a proof of concept. In our opinion, this is yet another example of the so-called ‘innovation paradox’: although many promising research expertises have been developed and made accessible for the Dutch market, innovation results are disappointing.

In this paper we present the approach that Telematica Instituut (TI) has been developing since 1997 in order to solve the innovation paradox. Also, we present a vision aiming at new roles for high tech SMEs in materialising new ways of knowledge production and dissemination. The crux of our vision is, as we will discuss in this paper, that HT SMEs are perfect societal actors that could speed up the innovation cycle between knowledge institutions and society, business in particular.

Furthermore, we present the Telematica Instituut consortium as a good practice example of the Dutch way towards Open Innovation. We argue that TI fits well in Chesbrough’s Open Innovation concept combined with the Mode-2 concept of Nowotny and colleagues. Both concepts will be described briefly and their relevance for Dutch innovation will be discussed, referring to opinions that are circulating in the present Dutch Open Innovation debate fuelled by the AWT (the Advisory Council for Science and Technology Policy).

Finally, the ‘Integrated Log’ platform will be discussed as a good practice of open source application that engages public organisations, SMEs and knowledge institutes as well. The Integrated Log Family is a set of open source CMS solutions developed for, and in collaboration with, stakeholders in the domain of care, cure, sports, and culture. We suggest that government-financed research should aim at impact, and open source software seems to deliver just that.

As ‘high tech SMEs’ (HT SMEs) are the focal point of this paper, we need to clarify that we use a rather broad definition, in contrast to the mainstream understanding of HT SMEs. We do agree that HT SME are dealing with high tech or high level expertise processes, products and/or services in an open market, organised in small or medium-sized entities of professionals; but we also include f.i. physiotherapists or financial
advisors. As players organised in small and medium-sized organisations and businesses, these professionals represent a work field that ICT aims to improve and innovate. Innovation research aiming at for instance ICT-enabled healthcare, trade, or education, should actually address the workers in these fields.

This paper is structured as follows:
In section 2 the Leading Technological Institutes initiative in the Netherlands is described. These Public Private Partnerships were established to bridge the gap between science and technology through collaborative projects. Telematica Instituut, which focuses on ICT-enabled innovation, is taken as an example.
In section 3 the innovation model of Telematica Instituut is compared to the open innovation model advocated by Chesbrough and the Mode 2 innovation model proposed by Nowotny and colleagues.
In section 4 we describe the Integrated Log Family, an open source infrastructure where Telematica Instituut researchers collaborate with professionals in the healthcare and sports domain to create multimedia management solutions that fit their ways of working.
In section 5 we discuss the roles that HT SMEs can play as innovation agents. By involving SMEs as co-developers, research projects can deliver results beyond the proof of concept level. Open source software guarantees freedom for partners to come and go.
In section 6 we draw conclusions about the changing role of Leading Technology Institutes. As innovators they shift from centralised to networked system integration involving communities and SMEs as advocates of end user parties. In open source projects they can reach out to these small and medium-sized organisations lending them a role as co-developer of readily usable innovations.

2. Leading Technological Institutes: Public Private Partnerships to stimulate innovation

Active partnering between actors in the Dutch public and private sector has been going on for a long time, primarily fuelled by private sector partners or societal entities. Creation of bottom up coalitions is a feature of Dutch society.
Dutch industry has been actively involved in policy formation on Dutch research & innovation policy, has been outsourcing and even dissolving its research capacity, and has embarked on consortial endeavours with universities and other companies.
In some innovation areas Dutch Government has expressed a strategic interest and commitment.

As a result of policy formation, in the mid nineteen nineties four ‘Leading Technological Institutes’ (Top Technologische Instituten) or LTIs were established in the framework of the policy ‘Kennis in Beweging’ announced by the Ministers of Education and Economic Affairs jointly. This initiative was launched in 1996 in order to ‘strengthen the innovation potential and competitive position of Dutch Industry’. In other words, LTIs should help in bridging the gap between the research in the (public) knowledge infrastructure and the knowledge needs of industry. See Figure 1.
2.1 The TRC and Telematica Instituut as an early example of Open Innovation

One of the strategic areas as elected by government is telematics: accelerating innovative ICT applications to boost Dutch business and raise social wellbeing. In the early nineties, a unique experiment had been launched by a coalition of the Dutch Government (represented by the Departments of Education and Economic Affairs), Dutch KPN, Philips and IBM. In close co-operation with the Dutch universities, the University of Twente in particular, the Telematics Research Centre (TRC) was founded as a foundation under Dutch law. The main impetus of TRC was to establish pre-competitive research programmes, joint ventures of industrial and public sector partners. In 1997 TRC entered a new lifecycle as one out of four LTIs, government wishing to establish pre-competitive public-private research institutes, the so-called ‘Leading Technological Institutes’. TRC was invited to submit a proposal for the new LTI scheme: Telematica Instituut was launched.

TRC was in fact an early example of the Dutch way to Open Innovation: a pre-competitive business club joining forces with academia. Telematica Instituut has been extending this model towards a wider set of project consortia, covering some 40 partners from public and private sector.

In practice, the position of Telematica Instituut covers a wider range of the spectrum than depicted above, as TI focuses at research on applications and deals in a lot of projects with project partners that are directly involved in development and exploitation. Furthermore, TI operates in a private sector context that is not being dominated by major ICT research partners, as most of private sector ICT R&D capacity has left The Netherlands.

2.2 Telematica Instituut’s organisation

2.2.1 Operating in a public and private context

The Telematica Instituut operates in a very complex setting. TI plays an active role in the governmental innovation policy framework, ranging from the management of national programmes on mobile communication, ICT in Health up to creation of project consortia in collaboration with governmental departments or provincial/local public authorities. The role of governmental bodies varies from subsidy allocation to launching customer for new products and services.
In the public domain TI has strong and growing links with knowledge partners, ranging from universities, public domain research institutes to universities of professional education (Polytechnics, Hogescholen).

The co-operation with private sector partners is twofold. Main players in ICT, telecom and ICT application are member of the TI-consortium, in 2006 some 15 companies. They play a dominant role in project formation and execution. An increasing amount of companies – among them SMEs – partakes in project consortia. Telematica Instituut manages about 60 projects annually, engaging some 60 private sector partners. As we will discuss in chapter IV, the extending co-operation with the ‘Stichting Innovatie Alliantie’ (Innovation Alliance Foundation) and establishment of ‘knowledge and business fora’ such as the Archimate Forum (a consortium for the advancement of software architecture) create new opportunities for SMEs to engage.

Figure 2 Comparing the four Dutch LTIs (source Technopolis)

As Figure 2 depicts, TI positions, compared to other similar research institutions, on the edge of research on applications and innovation. Where as TI started of in the early nineteen nineties as a research institute on ICT with a primarily technological focus, it has broadened its scope to research on applications, including and engaging partners that use and exploit ICT services in its project consortia.

2.2.2 Governance, scale, scope and orientation

Telematica Instituut is a foundation under Dutch law. In its governance structure, three elements are crucial:

- Daily operations and priority setting is the exclusive responsibility of the general and scientific directors, and the (20) project managers that report to them. This construction guarantees a maximum flexibility towards the market. The directors are accountable to a Board of Trustees who are being appointed by the consortium members.
- Mid term and annual priority setting is being approved by the consortium members via advisory bodies called Programmaraad (Programme Council) and Raad van Deelnemers (Council of Participants). In order to avoid that this year planning cycle
the ‘expertise communities’ comprising professors, R&D directors and senior staff of universities and companies within the consortium. These communities are being regularly consulted.

- The main programming instrument is the project consortium. All research is organised in programmes and projects. Companies and ‘clients’ from the public sector are the main drivers of project formation. TI’s account managers and business developers are in daily contact with potential clients - among them consortium members are in a preferred position – in order to assist pro-actively in bundling and articulation of business opportunities and related technological innovations.

Figure 3 The strategic research programme implemented through an annual scientific yearplan. Project consortia are formed in line with such annual plans (source Technopolis)

The result of these deliberations is depicted in Figure 3.

We feel that this configuration is crucial in order to adapt to the highly dynamic and short life cycle innovation environment that TI has to deal with. Different from the branches and working context of the other LTIs Telematica Instituut deals with research & innovation projects that have an average life cycle of 1,5 years in stead of 4 to 5 years. Also, TI is engaged in variety of branches as wide as healthcare, banking and finance up to chemical process industry, in stead of focussing on one branch.

The trade off for those consortium partners, in particular universities who are used to governance structures that resulting multi-annual research programmes, is that a broad spectrum of short life cycle projects boils down. This necessitates TI to invest heavily in proper communication and trust creation among consortium partners. As well on programme and project level as on the consortium level.

The orientation, scope and resulting scale of Telematica Instituut is another crucial feature as we see it. Different from the other LTIs Telematica Instituut deploys an extensive ‘central’ research and project organisation. This specific approach causes critical reflections from time to time, as some observers expect that a LTI is primarily a ‘virtual organisation’, a smart brokerage that mediates between universities and companies, but does not engage itself in research nor in innovation project execution.

Telematica Instituut has deliberately and based on extensive consideration taken this position as an innovation accelerator, including a substantial research and project organisation core staff. Telematica Instituut aims at delivering generic and integral solutions for industry and societal institutions. This approach results in a couple of
organisational requirements that are being described briefly before we deal with the concept of Open Innovation and possible roles for SMEs in more detail. As we will argue later on, TI’s position and configuration is a vital asset for effective engagement of SMEs.

# The research and development capacity has to be solution oriented, multi-disciplinary, flexible and substantial. Odd as it may be in view of the pervasive impact of ICT at the Dutch society, no research lab in the private sector nor in a university can meet these requirements. This has stimulated Telematica Instituut to bridge this gap, be it cautiously. TI does not head for a research staff of about three to four hundred researchers, including 200 PhDs as a university would do. Nor do we employ hundred fifty software engineers, as a software house would do. On the contrary. TI’s scientific staffing to date comprising 68 fte reflects a careful and lean and mean personnel approach. Almost all TI-researchers hold a PhD, TI itself employs only 7 PhD students and partially supports some 30 PhD students based at universities via its projects. All of them are recruited and being coached as multi-disciplinary team workers who want to build a career as innovation oriented researchers. As per 2006, some 70% of our staff has a degree in science and technology, some 30% in humanities and social sciences. Software engineers are vital in order to be able to swiftly develop mock ups, demos and test settings; it is crucial that these experts can work shoulder to shoulder with the researchers involved and that they are keen to apply generic applications in a variety of contexts. The amount and expertise of software engineers employed by TI is being carefully balanced with the amount and orientation of researchers. This capacity of 68 fte is a third of the total power of the TI-consortium: 197 fte including the researchers and developers from universities and companies engaged in projects.

# Private sector partners are to be taken on board, right from scratch, fuelling project conception up to execution and evaluation. Knowledge institutes tend to operate knowledge driven: first they define their multi annual research programmes, then they consult companies in order to see if a match could be made between the ongoing research projects in a department and the research or business interest of a company. This limits the scope, span of control and most importantly the orientation of university research programmes in their effectiveness for innovation programmes. Companies are struggling with other limitations. The other way around, companies, in particular those that do not run an R&D lab, do not know how to deal with research departments and are not able to articulate their ‘problems’ in terms of ‘scientific challenges’. This is one of the causes of the so-called ‘knowledge paradox’ or better said ‘innovation paradox’: more or even higher quality research does not automatically result in innovative solutions. Telematica Instituut solves this paradox to a certain extent. Some 8 fte senior academics with an extensive marketing experience are sitting from day to day in companies, in order to define projects and create project consortia. In most cases, these seniors also supervise project execution, chairing a supervisory team, balancing the interests of companies and knowledge institutions involved. We strongly believe that this high level marketing and project development cum supervisory effort is crucial in order to organise innovation projects that meet the – more often dynamic and shifting – demands of companies and societal institutions. Section 3.3 deals with these TI project consortia in more detail.
The operational organisation has to be project based, quick, transparent and accountable. All TI researchers are fully engaged in projects; this is being carefully monitored and managed by the so-called Resource Manager. The same goes for the TI support and management staff: 24 fte high level experts covering fields varying from project admin, project management, dissemination of project results up to literature and other electronic search support. The people work in direct contact with the project managers devoting about 60% of their time directly to projects. The main decisive result for the client is that TI is able to resource and start a project within a timeframe of 3 months. More over, projects are governed in a transparent way, stakeholders and project partners being fully involved in monitoring and governance. In doing so, TI has achieved a strong reputation among public and private partners as a reliable and productive partner.

This brief analytic description illustrates why Telematica Instituut has chosen for a rather unique configuration. A final observation concerns the overall size and scope. As ambitious and challenging as this approach may be, the bottom line is that TI operates in a smart way, not duplicating research as conducted in universities and not competing with companies that exploit results of our innovation projects. This is a vital feature for TI’s role as an accelerator in Open Innovation consortia.

In its 2005 evaluation of the LTIs, Technopolis concluded that LTIs have had a positive impact on companies’ collaboration attitudes and increased openness in sharing R&D intentions with other firms. “Trust building has taken each of the firm’s time to develop. In the modern economy depending on open innovation this is an important learning effect. The existence of the instrument in itself offers firms a platform for business-to-business collaboration, which would be very difficult to achieve without such a mechanism. The sustainability of the networking effect is therefore very dependent on the LTI instrument: without the instrument collaborations would most likely become more focused on bilateral relations.”

3. Telematica Instituut’s innovation model seen from two perspectives

In the Introduction to this paper we introduced ourselves as critical observers of the Open Innovation concept. In this chapter we will reflect on this concept, making best use of our experience with Telematica Instituut as a good practice example of Open Innovation. Furthermore, we will refer to some of the essays that were published by the Dutch AWT (the Advisory Council for Science and Technology Policy) from angles such as science research, ICT development, economics and political philosophy.

3.1 Open innovation

Open Innovation is becoming a new buzz word in The Netherlands. It took a while before Harvard’s professor Chesbrough’s concept touched base in the Lowlands. And even now, in May 2006, this wind of change has not fully reached all corners of academia nor boardrooms of companies and public sector institutes. Nevertheless, Dutch internationals such as Shell and Philips are embarking on new coalitions and have been telling the new new story to policy makers and academics for some time.
Critical observers to whom the authors gladly count themselves may argue: what’s new? Especially seen from the perspective of the Dutch standpoint: Holland, the country known for its international role as raider, peacemaker, coalition creator, smart player in international consortia. On a national level reflected in our once famous Poldermodel. It is helpful and inspiring that the Dutch AWT has launched an essay competition in winter 2005. The wide variety of essays nicely reflects the different viewpoints from the public and private sector, as well as from a range of scientific disciplines. The concept of Open Innovation has inspired the authors to write this paper, telling the story of a fairly unique Dutch innovation entity, Telematica Instituut (TI). TI happens to be one of the oldest examples of the Dutch way towards Open Innovation. Based on its strong track record in this field, the new top management team that came into force in 2005 is launching new policies that include an enhanced role in Open Innovation and the inclusion of SMEs in its operations.

In using the term “Open” and ‘inspiration’ the reader should be warned: we are not naïve. In our opinion, ‘Open Innovation’ is a new power struggle, a rather disruptive and unpredictable dynamic context for big and small companies, governments and academia alike. As democratic, or even rosy and romantic the term ‘open’ might seem to refer to: it is a struggle, a new playing field posing new challenges that we have to live up with.

3.1.1 Chesbrough’s concept of Open Innovation
Chesbrough (Harvard) defined in 2003 under the banner ‘Open Innovation’ his concept, based on reflections on the way that major American companies deal with intelligence and resource sharing. The following table enlightens the key-features of Open Innovation as Chesbrough defines it.

<table>
<thead>
<tr>
<th>Closed innovation principles</th>
<th>Open innovation principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>The smart people in our field work for us.</td>
<td>Not all the smart people work for us. We need to work with smart people inside and outside our company.</td>
</tr>
<tr>
<td>To profit from the R&amp;D, we must discover it, develop it, and ship it ourselves.</td>
<td>External R&amp;D can create significant value; internal R&amp;D is needed to claim some portion of that value.</td>
</tr>
<tr>
<td>If we discover it ourselves, we will get it to market first.</td>
<td>We don’t have to originate the research to profit from it.</td>
</tr>
<tr>
<td>The company that gets an innovation to market will win.</td>
<td>Building a better business model is better than getting to market first.</td>
</tr>
<tr>
<td>If we create the most and the best ideas in industry, we will win.</td>
<td>If we make the best use of internal and external ideas, we will win.</td>
</tr>
<tr>
<td>We should control our IP, so that our competitors don’t profit from our ideas.</td>
<td>We should profit from others’ use of our IP, and we should buy others’ IP whenever it advances our own business model.</td>
</tr>
</tbody>
</table>

3.1.2 Reflections on the concept of Open Innovation from a Dutch perspective
As triggering as it may be, the concept of ‘open innovation’ as presented by Chesbrough is mainly being studied from the perspective of and consequences for major private sector firms.
In the Dutch context, Chesbrough’s vision may apply for the private sector. Major companies have embarked on Open Innovation. LTIs and TNO are busy in creating coalitions, but the most visible examples are Dutch internationals such as Shell, ASML, and Philips. Van de Schootbrugge (TNO 2005) registers from TNO’s cooperative experience with Shell the following motives from this Dutch multinational for engaging in coalitions:
- establishing and maintaining contacts with excellent researchers outside own company
- improve own overall knowledge
- results of the projects (only third place!)
- sharing knowledge even with competitors is counterbalanced by these advantages
- there are more brains outside than inside

We will discuss perspectives for SMEsin more detail in the next chapter.

Different from the private sector, we expect that Chesbrough’s vision does not cover the challenges that lay ahead for Dutch universities and other knowledge institutions. He focuses on an appeal to universities and government. As companies can no longer invest in central R&D labs, R&D becoming increasingly distributed in nature, universities should expand their fundamental research, and governments should fund this. Moreover, governments should stimulate knowledge transfer from universities to industry, and universities should allow academic staff to engage in entrepreneurial activities. This limited attention for the repercussions on universities may be true for American universities, however in our opinion consequences for Dutch universities and other knowledge institutions such as the LTIs will be substantial. Countering Open Innovation challenges issued by private sector parties is an extra trigger for university departments to transform into an innovative (cluster of) department(s) and to organise new interfaces and organisational set ups with industry.

### 3.1.3 Dutch opinions on open innovation

After this brief reflection on Chesbrough’s vision with regard to major Dutch companies and research institutes, let us now zoom in at specific aspects of the Open Innovation concept, making grateful use of some of the essays that were published by the AWT in 2006.

First, Patrick van der Duin, Dap Hartmann and Roland Ortt (TUD, Sectie Technologie, Strategie en Entrepreneurship state in their essay “Innoveren in nieuwe tijden” that Chesbrough’s model of linear innovation (from knowledge to market) is anachronistic. They suggest to use a model of cyclical innovation (cf. professor Guus Berkhout) and describe innovation in terms of system dynamics, resulting in a learning system of interrelated innovation clusters. Furthermore, they criticise his focus on companies as sole drivers of open innovation: it is too narrow. Referring to Von Hippel they pose that consumers and societal organisations are important sources of innovation. In addition to Chesbrough’s vision that major companies are drivers of Open Innovation consortia, they suggest to have “innovation initiators” organised, f.i. to give the LTIs a broader task as “Innovation Institutes” that relate to as well science, technology, companies as the market.
Interestingly, Telematica Instituut has been developing a profile as ‘innovation institute’ for some time now, focusing at establishment of ‘innovation fora’.

Second, André van Hoorn (RU Nijmegen School of Management) relates Open Innovation consortia to former ‘collective innovation’ coalitions that already existed in the 19th century. Open Innovation coalitions are in his view a logical result of enhanced international competition and scale of operations. He argues that once companies are able to organise innovation via Open Innovation coalitions, role of government changes. In his opinion government should primarily stimulate open access to research and innovation results, and should promote diffusion of results. The recently introduced ‘Innovatievouchers’ (innovation vouchers) for SMEs are in his opinion a proper instrument for knowledge diffusion, particularly when these vouchers are being allocated in the framework of coalitions between companies.

Based on our experiences, we agree with Van Hoorn that the role of government should change: more autonomy could be given to public private consortia where by government should keep the LTIs accountable for open access to project consortia and active dissemination of results. SMEs could benefit from participation in these consortia or from access to results. Telematica Instituut is well equipped to organise open access for SMEs.

Third, Ferdinand Jaspers (EUR Institute of Management) presents in his paper ‘Open innovatie: contingenties, systeemintegratie en beleid’ a thorough analysis of organisational mechanisms in the wider framework of technological innovation. Also, he tries to differentiate between kinds of innovation and organisational frameworks. After a critical reflection on four kinds of innovation as defined by Chesbrough & Teece (Incremental versus radical innovation, modular versus architectural innovation) he poses his own definition of Open Innovation (our interpretation and translation):

“Open Innovation can be seen as a set of mechanisms that covers the best of both worlds. It offers access to technologies on the market (modular innovation, incremental innovation) and enables systems integrators to coordinate networks of companies based on their knowledge of overarching architectures and improve their architecture based on architectural feedback out of this network (dynamic system integration). These system integrators, most often major players, are necessary able to enforce radical innovations within their own company (conglomerate)”. Central in Jaspers’ paper is the role of the systems integrator: the company that is able, based on architectural expertise and R&D capacity, to coordinate networks of companies.

In the Dutch context, LTIs such as Telematica Instituut are playing the role of system integrator, in doing so stimulating learning by doing fora that are open to other users, beyond the major companies.
3.2 Mode 2 science and the role of knowledge institutions in Open Innovation

The concept of ‘Mode 2 science’ has been defined in the early nineteen nineties by Nowotny, Scott and Gibbonsvi (ETH, Kingston University, Association of Commonwealth Universities), later on elaborated towards the ‘Mode 2 society’ and the ‘Mode 2 University’.

In order to understand the possible repercussions of Open Innovation for knowledge institutions we would like to refer to the concept of ‘Mode 2 Science’. Mode 2 Science, in short, refers to multi disciplinary approaches, in contrast to the traditional disciplinary order of academic disciplines.

Dutch universities show good practices of Mode-2 sciencevii: major efforts to create ‘strategic science’ clusters of multi-disciplinary research and learning networks, as well within as in between universities. All Dutch universities by now established interfaculty research institutes and interuniversity research schools, some of them allocating 80% of their research capacity in these ‘programme institutes’. Industry is linked or even involved in these institutes in various ways, by partaking in advisory councils up to co-making research programmes.

The concept of Mode 2 science has inspired many academics to reflect on, it has been a controversial concept for years now. In their latest book, ‘Re-Thinking science; knowledge and the public in an age of uncertainty’viii, four concepts are key in their analysis:

• The nature of the Mode-2 society;
• The contextualisation of knowledge in a new public space, called the agora;
• The development of conditions for the production of socially robust knowledge;
• The emergence of socially distributed expertise.

Their conclusion is that “closer interaction of science and society signals the emergence of a new kind of science: contextualised, or context-sensitive, science.” (p 4).

Another interesting part of their thinking concerns the concept of the “Mode 2 University”. They state that university managers nowadays have to deal with extremely complex challenges, among them the ‘de-institutionalisation’ of university systems. As controversial as this may seem, a strengthening of the strategic management of an innovative university does not imply that demarcation lines within or around a university system have to be frozen, on the contrary: decentralisation, flexible arrangements between teaching and research programmes and networked (international) alliances with external research institutes seem to be the modern pathways for a university system in transformation. We do recognise their observations from our own experience: the strategic necessity to combine a stronger and even more focused research profile with a broader and more diversified profile in application research, business development and dissemination.

This concept relates in our opinion to the concept of ‘ambidexterity’ (Harvard’s professor Tushman a.o.)ix. Knowledge organisations need to be efficient as well as innovative. If we project this vision on coalitions of public and private partners, Open Innovation...
consortia, a specific requirement for SMEs would be that these coalitions are as well innovative (risk taking, risk sharing, intelligence sharing) as efficient. Efficient not only in terms of the ROI, but merely in terms of alignment with markets and operations of the SMEs concerned.

3.3 The innovation process at work in Telematica Instituut

In addition to the description given in par. 2.2 of the Telematica consortium as a good practice example of Open Innovation, in this paragraph we briefly describe the way that TI creates and facilitates public-private project consortia.

The Leading Technology Institutes are unique in terms of their organisation and approach. The LTIs are characterised by:

- **partnership.** Companies work with universities and public research organisations in the leading institutes to create and implement programmes of research and innovation. This enables the combination of market-led demand with the scientific knowledge supply in a continuous iterative process, a process that determines the direction research should be taking. The partners also contribute financially. Companies and knowledge institutions provide the leading institute with support, either in kind or in terms of finance, and the government then matches the participants’ contributions.

- **a primarily virtual organisation.** Researchers working for the institute are joined in an LTI by researchers from businesses and knowledge institutions. They work closely together for various lengths of time on programmes and projects. Once their work is complete, the external researchers return to the company or institution from which they came or they may be hired by an LTI. This gives the LTIs a degree of flexibility and enables them to adapt their research programmes to match developments in the market, society and science. This structure also facilitates the linking of knowledge demand with supply.

- **pre-competitive research programmes.** Together and with their knowledge partners, companies in the LTI carry out multidisciplinary research in the initial phase of innovation. Research is organised in a programme, focuses on the mid and long term and tends to be pre-competitive. That is also of interest to knowledge institutions; the research that companies generally outsource to them tends to be developmental. An LTI orchestrates research and innovation in a particular key area.

- **networks and knowledge transfer.** A unique characteristic is that participants from the entire industry chain (suppliers, competitors and buyers) meet one another in the LTIs, a platform whose approach is replicated nowhere else. As well as industry participants, the network also includes knowledge institutions and the government. The LTIs aim to initiate the exchange and transfer of knowledge between the partners, preferably in the form of applications and tangible innovations.
These leading principles result in a specific approach for Telematica Instituut that can be summarised as follows:

- In its projects, TI creates public-private innovation communities. TI facilitates and stimulates knowledge sharing and circulation within these communities. In order to enforce this, among others practical measures, TI adopts during the project life cycle the role of representative for the assembled stakeholders. Actually, TI appoints a senior supervisor chairing a project steering group who ‘governs’ the project and takes care of stakeholder management.

- In terms of technology development and innovation, TI stimulates and facilitates that:
  - Competing companies co-operate in the development of future standards;
  - Suppliers of complementary products and services coordinate their strategies and products/services, in order to create effective business models;
  - Suppliers and users in a vertical chain optimise their operations in order to raise the overall efficiency and to develop and exploit new market opportunities;
  - Technology suppliers and users meet in order to raise the mutual awareness of user demands and technological constraints and opportunities, in doing so creating opportunities for new products and services;

- Finally, TI assists and stimulates SMEs to join forces among themselves and with major companies, in order to be able to engage in joint innovative R&D.

Telematica Instituut performs this role based on reputation and trust that has been achieved since its launch in the mid nineteen nineties. A range of projects has been conducted, culminating in a variety of current projects, for instance:

- The Archimate Forum – a consortium of software houses including SMEs and science partners for the advancement of software architecture.
- The Integrated Log Initiative – an open source infrastructure, initiated by the national research programme, MultimediaN aiming at co-development of content management solutions together with SMEs in the healthcare, sports, and culture domain.
- ISI – a collaborative effort with Dutch insurance companies to help their sales entrepreneurs (middlemen) develop an ICT strategy in their everyday business.
- The Innovation Alliance Foundation – for collaboration between professional education (hogescholen, polytechnics) and SMEs aiming specifically at organising innovation communities around technology topics such as ICT, environment, healthcare, etc.

4. Example: Integrated Log Family as open source project

The Integrated Health Log project (Brussee et al, 2005) which is part of the Dutch national MultimediaN research initiative (www.multimedian.nl), is a collaboration project from IBM, Roessingh Research and Development and Telematica Instituut. In the Integrated Health Log project the team developed an open source infrastructure to manage, share and use multi data. Inspiration for this initiative came from earlier projects, and discussions with representatives from home care, healthcare, culture and sports who demanded solutions enabling them to collaborate while sharing various multimedia in a secure environment.
In the care case the focus lay on home care applications where district nurses kept a patient log of wound care and could consult a colleague or a dermatologist for advice. In the cure case developers chose a focus on rehabilitation medicine. Here specialists and therapists wanted to combine the data of a patient collected over different treatment sessions and discuss these data with peers. In the sports case developers focussed on the communication between trainer and pupil. Their aim was to have training data be uploaded so that trainer and pupil could discuss and compare these data afterward, even over distance. In the culture case, the focus was on the autonomy of artists and culture institutions. They wanted to open specific parts of their portfolio to specific groups but would be reluctant to put everything on the web for free, to prevent digital copying of their work.

The users in the designated cases needed a content management system (CMS) like solution but they had bad experiences with CMSs that made them hold on to grass roots initiatives such as websites set up with no larger organisation in mind. Inspired by the steady growth in network connectivity, bandwidth and memory space, the integrated log family was built in an open source manner, based on the popular Plone/Zope open source system (http://plone.org) that were made fit for logging a wide variety of multimedia and giving the users the ultimate autonomy to decide what to share with whom. Out of this endeavour grew the Integrated Log Family.

To test the viability of the integrated log family, the team IHL team organised expert meetings with stakeholders from rehabilitation medicine and from the sports domain. On the one hand the software served as a rapid prototype to evoke user feedback and enable iterative improvement. On the other hand, the CMS worked properly, even in this prototype phase, because of the solid Plone basis underneath and the Apache access infrastructure that had been included. The system included a basic infrastructure with several multimedia management functions.

Figure 4: SportersLog prototype: role based access to rich multimedia
In the rehabilitation case, Roessingh R&D decided upon using the system for patient intake as internal multimedia patient record and for child physiotherapists to share cases in peer review meetings for learning and quality management.

For the sports umbrella NOC*NSF (Netherlands Olympic Committee and Sports Federation) a similar small scale growth path was foreseen. First the system is being tested at two federations, the swimming federation and the cycling union with a further roll out foreseen in case of a positive pilot outcome. Figure 4 shows a prototype. Currently these pilots are running. That is, the IHL-team has put doctors, therapists, trainers, and sportsmen at the helm. In a rapid evolution new functions are being demanded, small problems are being addressed. And the end users start to give the Physiolog and Sporterslog a place in their everyday routine. Earlier studies in home care, “Woundlog”, showed that this appreciation for the technology is essential.

The Plone open source portal software and the Apache open source security infrastructure have been the team’s starting point. This open source approach allows a basic structure consisting mostly of ready-made fabric, but tailored in a few details that are relevant for the business. This makes solutions affordable and manageable. The general architecture encompasses the business needs that are generally felt, such as security, data management, communication, and access. Moreover, it allows easy adaptations. The Plone and Apache development communities guarantee state of art and flexible solutions. The stakeholder community of SportersLog consists of coaches, technicians, researchers, advisors, and medics. Many parties are involved. Three quarter of these stakeholders are semi independent autonomously working SME parties. Some independent organisations, but also federations themselves have a scale, budget, and focussed scope similar to SME. For them ICT is only valid if it brings a solution. Upfront strategic investments are undoable there.

5 Including HT SMEs as a condition for ICT-enabled innovation

Before entering into conclusions and issues for further research and discussion, as we will do in the next section (chapter 6), we would like to elaborate on the importance of including HT SMEs in innovation processes, in order to get innovation results that are effective for the end user, scalable and sustainable. As the focus of this paper lies on ICT-enabled innovation, we will extend lessons learned from the Integrated Log case onto open source communities.

First, an important aspect of open source software is that allows community partners of different size and nature to create a dynamic community. There is no need for a major player that coordinates the overall architecture. Likewise, exchange of intelligence is possible in an early stage, SMEs can be early engaged, they do not have to wait and see till a major player feels it to be proper to allow them to engage in dissemination. It is ideal during prototyping because it’s modifiable.

Second, a dynamic community combines the necessary autonomy with a partial sharing of roles. If we want the system to stay alive and evolving, it must be adaptable in the
future as well. Therefore we’d best lift the barrier between prototype and end product and strive at far reaching co-design with the users in these fields in an iterative manner – now and in the future. This is a combination of freedom and a willingness of stakeholders to adhere to a common (open) standard.

Thirdly, open and dynamic innovation communities require a substantial amount and variety of participants, with an independent and robust accelerator and facilitator such as an LTI. The SportersLog example is interesting because a lot of stakeholders may actually be involved. This becomes clear, e.g., when we focus on the future of this open source infrastructure. Continuation needs to be organised and the open source community has blue prints for that. To involve this large community of interest - as is necessary - any sensible initiative in this direction should be maximally open. This gives a social basis for the effort to continue.

The term ‘social’ refers to the democratic aspect of Open Innovation, also to our previous conclusion that SMEs could play the role of ‘societal actor’ par excellence. Here we think lies the fundamental advantage of open innovation compared to closed innovation.

Leaving out some of these stakeholders, e.g. because of their size or (lacking) financial power, would only make a product like SportersLog less relevant. This is because the bulk of the activities and responsibilities in the sports domain are organised through small and medium-sized organisations and businesses.

In order for this open source infrastructure initiative to continue after Telematica Instituut finalises its Integrated Log activities, the institute proposes one or several not-for-profit foundations to guard the character of the software being built. These foundations are governed by a representation of the stakeholder groups. The more organisations adhere to this foundation, the more relevant a related open source product can grow. The GNU Public Licence (www.fsf.org) serves as blue print for the corresponding open source licences for SportersLog and other members of the Integrated Log Family. The bottom line here is that access to the software is guaranteed and maintenance of the software can be organised. These conditions lower the risks for SMEs (and all other enterprises) when they invest their time and money in an open source products.

6. Conclusions: changing innovation, changing roles

Open Innovation as academics from The States tend to define it, is driven by companies, where in knowledge institutes serve the purpose of accelerating or optimising innovation processes. In addition, inspired by European scholars who develop the Mode-2 science concept, we would prefer to include societal actors and knowledge institutes as essential drivers of innovation.

In this paper we described the Dutch Leading Technology Institutes initiative and the particular example of Telematica Instituut. By showing its governance, its project organisation, and a typical collaborative project in the domain of open source, we demonstrated that Leading Technology Institutes can play a prominent role as innovators.
As we see in the example of the Integrated Log Family, sections 4 and 5, SMEs need to be welcomed and involved to accelerate innovation and translate it to effective end user applications. So SMEs can be as important innovation accelerators as larger companies. Therefore the innovation role of knowledge institutes needs to broaden in the future to connect with both large and small businesses, large and small organisations.

For such community- or ecosystem-oriented innovation to work, roles must be decentralised. The “industry age” centralised system integrators must gradually give room to more “knowledge age” networked ecosystems approaches. Open source initiatives may very well guide our way. They show that size plays a lesser role in this knowledge paradigm, but social basis does.

We expect therefore that SMEs in the future will see their role in research projects broadening. Currently they are mostly involved as pilot partners in project activities targeting end user groups. Collaborative efforts like the Integrated Log applications show that SMEs can be co-developers and partners in R&D as well.

For Telematica Instituut, as a consortium and as a multi client programme management entity, the role is changing as well. The institute may become a pivot and good practice example of Open Innovation in itself. Being an efficient and reputed organiser of innovation programmes and projects, is may extend its future role as a productive docking system for HT SMEs.

In ICT-enabled innovation, dynamic open innovation communities, comprising as well SMEs as public institutes, supported and stimulated by an independent body such as Telematica Instituut, could be crucial for accelerated and sustainable innovation. Government should sponsor bodies such as the Leading Technology Institutes in their role to guarantee open access to these innovation communities and pro-active dissemination of their results.

Notes

ii Technopolis 2005; Evaluation Leading Technological Institutes, assigned by the Ministry of Economic Affairs
iv G. A. van de Schootbrugge. Open Innovation, a challenge for RTOs. EARTO Conference, Warsaw, April 15, 2005
v Open stellingen Essays over Open innovatie (Achtergrondstudie nr. 32), AWT (the Dutch Advisory Council for Science and Technology Policy), Den Haag 2006
High-tech small and medium sized enterprises’ use of methods and tools for external knowledge integration

Jeroen Kraaijenbrink

Dutch Institute for Knowledge Intensive Entrepreneurship (NIKOS), University of Twente
P.O. Box 217, 7500AE Enschede, j.kraaijenbrink@utwente.nl

Abstract

External knowledge integration (EKI) is the process by which organizations identify, acquire, and utilize knowledge from their environment. While there is a vast array of methods and tools (MTs) available to support this process, it seems that high-tech small and medium sized enterprises (HTSMEs) hardly use them. This study investigates a) whether this is correct for a variety of MTs, b) what is the level of satisfaction with these MTs, and c) what are potential causes for a low usage. A survey with results from 317 HTSMEs shows that the usage of MTs to support EKI is indeed low, in particular for very specific MTs. Moreover, it appears that users are satisfied with the MTs they use and that not being aware of MTs is the most important reason for not using them. Suggestions are provided as to how usage of MTs for EKI amongst HTSMEs can be improved by increasing awareness.

1. Introduction

Given the numerous governmental initiatives for it, improving the transfer of knowledge to high-tech small and medium sized enterprises (HTSMEs) appears to be a highly relevant topic (Bougrain & Haudeville, 2002). For example, governments provide subsidies, give training, found knowledge-brokering institutes and websites, and support collaboration between HTSMEs and research institutes (Jetter et al., 2005). While governmental initiatives are undoubtedly helpful in supporting the transfer of knowledge to HTSMEs, they are not the only way to support them. An alternative way to support HTSMEs is by providing them with the methods and software tools (MTs) they need to identify, acquire, and utilize external knowledge themselves. This process of identifying, acquiring, and utilizing knowledge from their environment is called external knowledge integration (EKI) in this paper.

There exists a vast array of MTs that are potentially useful to support EKI in HTSMEs. In this paper, methods are considered to be ways of thinking and acting when approaching a problem. Examples of methods are benchmarking, gap analysis, and internal documentation procedures. Tools are considered as instantiations of such methods in pieces of software. Examples of tools are data mining software, content management systems, and groupware. As a number of studies show, the usage of these MTs, and in particularly tools, is low amongst HTSMEs – and SMEs in general (Bessant, 1999; Corso et al., 2003). This seems not surprising, since most MTs have been developed by and for large companies and most studies on MTs are also on large companies (Binney, 2001; Nissen, Kamel, & Sengupta, 2000; Paton, Goble, & Bechhofer, 2000; Ruggles, 1997). Though perhaps not surprising, I find it striking when an economically crucial group of companies like HTSMEs is not using...
potentially useful MTs to support their EKI processes. This seems to imply that EKI, which is a crucial process for HTSMEs, is not supported to the extent it could be supported with the available means. It is the purpose of this study to find out to what extent this is indeed the case and why so, and to generate ideas on what can be done about it.

While some previous studies have been conducted on MTs’ usage in small firms, these studies have focused on a rather narrow set of MTs, or even on the evaluation of a single MT (e.g., Bessant, 1999; Scherf & Böhm, 2005). I have found no study systematically analyzing the usage of a broader range of MTs for EKI amongst HTSMEs. To address this lacuna in the current literature, this paper presents the results of such study. The objective of this paper is to answer the following three questions:

1. To what extent are a variety of existing MTs used by HTSMEs?
2. What is the level of satisfaction with these MTs amongst HTSMEs?
3. What are the causes for a low usage of MTs amongst HTSMEs?

The answers to these three questions will provide a better insight in which MTs HTSMEs do use and which MTs they do not use and why this is the case. Based on this insight, the paper provides suggestions for how to increase the use of MTs amongst HTSMEs.

The paper is structured as follows. The next section presents the research method of a survey that was conducted in order to answer the three questions. Consequently, Section 3 provides the results of the survey. The paper ends with a conclusion in Section 4 and a discussion in Section 5.

2. RESEARCH METHOD

The answers to the three research questions were sought by means of a large-scale online and paper-and-pencil based questionnaire sent to a stratified randomized sample of 1306 HTSMEs in Germany, Israel, the Netherlands, and Spain. The complete survey concerned a wide range of topics related to EKI and was conducted as part of the European project ‘Knowledge Integration and Network eXpertise’ (KINX). Approximately one-fifth of this survey was reserved for the answering of the three questions related to this study.

2.1 Questionnaire

Based on existing inventories of MTs (Bullinger, Wörner, & Prieto, 1997; KLUG, 2002; Sebastiano & al., 2002) we made a selection of MTs that should be covered in the questionnaire. The final questionnaire provided a list of 15 types of methods and 17 types of software tools that all could be used to support the identification, acquisition, and utilization of knowledge (see Figures 1 and 2). For each MT, respondents were asked to indicate whether they (had) used it and, if so, whether they were satisfied with it or not. These questions were in a simple yes/no format.

To get a better insight in the type of methods and tools that were used, a second question that was asked concerned the degree to which the methods and tools that are used are standard or customized. Respondents were asked to indicate on a 5-point scale ranging from strongly disagree (1) to strongly agree (5) to what extent they agreed with the following two statements: 1) Most of our methods and software that deal with knowledge are especially developed for our company, and 2) Most our methods and software that deal with knowledge are specific for our field.

Finally, the questionnaire asked for reasons why respondents did not use MTs more often. Based on a meeting with an expert team of HTSME managers, consultants, and academics (the KINX consortium) and 33 exploratory interviews with HTSME managers, the following options were chosen: ‘Not thought about it’, ‘There is no need for it’, ‘I am not aware of any’, ‘There are too many to choose from’, ‘They are too expensive’, ‘There are no
suitable ones’, and ‘It is too complicated to learn to use them’. Also, respondents had the opportunity to choose the option ‘Other reason, namely…’. This question was asked for each of the three stages of EKI (identification, acquisition, and utilization of knowledge) and for two types of knowledge (customer/market knowledge and technological knowledge).

2.2 Sample

In order to create a sample of HTSMEs, we had to specify what we mean by ‘SME’ and by ‘high-tech’. The formal European definition of SMEs includes companies that have fewer than 250 employees (European Commission, 1996). However, while the average company in Europe has 6 employees, for those branches that are defined as high-tech manufacturing by the OECD (2001) the average number of employees is 20. This implies that the average size of the companies this study focuses on is more than three times as high as the overall European average. Therefore, we included companies with up to 500 employees in our study. For the definition of ‘high-tech’ companies we adopted the official International Standard Industrial Classification (ISIC) of high-tech and low-tech industries. This study includes firms of both high-technology and medium-high-technology industries (see Table 1).

A major challenge was the selection of high-quality address databases for the questionnaire. Since we are not aware of any database that covers the four countries, we had to select four different databases that allowed selection on similar criteria. Because of their high-quality reputation and similarity, the following databases were selected: Hoppenstedt (Germany), D&A HiTech Information Ltd. (Israel), National Chamber of Commerce (Netherlands), and AXESOR (Spain). From these databases, we selected a stratified random sample of 1722 HTSMEs. The sample was stratified over country (Germany, Israel, Netherlands, and Spain), size (2-9, 10-49, 50-99, and 100-499 employees), and industry (industries 24 and 29-35 from the International Standard Industrial Classification). These companies were contacted by phone, were asked to identify a key informant, and received a personal (web based or paper-and-pencil based) questionnaire with an accompanying letter. Although the validity of single-informants research has been debated, Campbell (1955) concludes that this type of sampling can produce results that are valid and generalizable. Also, we agree with Kumar, Stern, & Anderson (1993) who state that informants are not selected to be representative of the members of a studied organization, but because they are supposedly knowledgeable and willing to communicate about the issue being researched. Since smaller companies are less likely to have such informants than large companies (Mitchell, 1994), we let companies decide themselves who was the most appropriate person to respond. During the telephone calls we asked respondents whether they were indeed the right person in the company to answer the questionnaire. We had expected that this self-selection mechanism would lead to a strong overrepresentation of technology-oriented respondents compared to market-oriented respondents. This expectation was based on an assumption that NPD in HTSMEs would be associated with research and development rather than with marketing. While our expectation was partly right, also a substantial number of market-oriented persons responded. When the selected respondents did not respond within the indicated period (two weeks) they were reminded up to two times, which is reported to be the optimal number of reminders (Babby, 1995).

2.3 Response

From the 1722 SMEs that were initially selected, 416 were excluded from the sample for several reasons, including wrong addresses and wrongly classified as HTSME. A total of 317 HTSMEs responded, leading to an effective response rate of 24.3 %, which is considerably high for a randomized sample of SMEs (Huang, Soutar, & Brown, 2002; Raymond, Julien, & Ramangalahy, 2001).
The profile of the responding companies and individuals is given in Table 1. A comparison (t-test and Mann-Whitney test) of respondents with non-respondents showed no significant differences on industry (2-tailed significance for t-test was .904 and for Mann-Whitney was .516). However, regarding company size the difference were significant (both tests showed a significance of .000): companies with 10-49 employees were relatively underrepresented in the response set, while companies with over 100 employees were relatively overrepresented. Also concerning company age, differences were significant (.083, respectively .002 for t-test and Mann-Whitney test). Younger companies were relatively underrepresented, while older companies were overrepresented. We had no theoretical reasons to assume that these over- and under-representations were relevant for the outcomes of the study. Moreover, a comparison (t-test) of early and late respondents on all variables in the complete study showed no significant differences (at p<0.05). Thus, substantial non-response bias seems unlikely (Armstrong & Overton, 1977).

### Table 1 Profile of respondents and their companies

<table>
<thead>
<tr>
<th>Industry</th>
<th>%</th>
<th>Year of foundation</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Chemicals &amp; chemical products</td>
<td>10.7</td>
<td>Before 1965</td>
<td>13.1</td>
</tr>
<tr>
<td>29 Machinery &amp; equipment</td>
<td>28.4</td>
<td>1966-1980</td>
<td>13.1</td>
</tr>
<tr>
<td>30 Office machinery &amp; computers</td>
<td>11.7</td>
<td>1981-1990</td>
<td>18.0</td>
</tr>
<tr>
<td>31 Electrical machinery &amp; apparatus</td>
<td>4.1</td>
<td>1991-1995</td>
<td>14.6</td>
</tr>
<tr>
<td>32 Radio, TV and communication equipment</td>
<td>19.9</td>
<td>1996-1998</td>
<td>15.5</td>
</tr>
<tr>
<td>33 Medical, precision &amp; optical instruments</td>
<td>12.6</td>
<td>1999-2001</td>
<td>16.2</td>
</tr>
<tr>
<td>34 Motor vehicles, trailers &amp; semi-trailers</td>
<td>5.0</td>
<td>Missing</td>
<td>9.5</td>
</tr>
<tr>
<td>35 Other transport equipment</td>
<td>3.2</td>
<td>(after 2001 excluded)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>4.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of employees</th>
<th>Total</th>
<th>On R&amp;D</th>
<th>Position of respondent</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-9</td>
<td>14.3 %</td>
<td>58.5 %</td>
<td>Director/general manager</td>
<td>29.9</td>
</tr>
<tr>
<td>10-49</td>
<td>28.7 %</td>
<td>23.2 %</td>
<td>Manager/head R&amp;D</td>
<td>37.8</td>
</tr>
<tr>
<td>50-99</td>
<td>16.5 %</td>
<td>5.2 %</td>
<td>Manager/head marketing</td>
<td>14.3</td>
</tr>
<tr>
<td>&gt;=100</td>
<td>35.1 %</td>
<td>3.4 %</td>
<td>Other</td>
<td>12.8</td>
</tr>
<tr>
<td>Missing</td>
<td>5.5 %</td>
<td>9.8 %</td>
<td>Missing</td>
<td>5.2</td>
</tr>
<tr>
<td>Mean</td>
<td>89.5 %</td>
<td>14.8 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. **RESULTS**

The results of the survey are presented below in Figures 1-6. Figure 1 presents how many of the 317 respondents used or have used one or more of 15 types of methods (black bars). It also presents how many users were satisfied with each of the 15 methods (white bars). The right column in Figure 1 represents the ratio of respondents that were satisfied with a method and respondents that were not satisfied with that method. Figure 2 is identical to Figure 1, but concerns tools instead of methods.
Figure 1 Number of respondents that use certain methods and that are satisfied with them (adapted from Krajienbrink, Groen, & Wijnhoven, 2005)

Figure 1 indicates that the methods that are used most are general methods, such as brainstorming (253 out of 317 = 79.8%), documenting (218 / 317 = 68.8%) and regular meetings (214 / 317 = 67.5%). Figure 1 also shows that the least used methods are appointing a knowledge manager (46 / 317 = 14.5%), relationship management (49 / 317 = 15.5%), and bulletin boards (54 / 317 = 17.0%). This implies, for example, that approximately every sixth to seventh responding company has implemented a bulletin board and appointed a knowledge manager. Though these methods score lowest compared to the other methods, we find the number of HTSMEs that have appointed a knowledge manager remarkably high.

When we look at the right column of Figure 1, the fact that all ratios of satisfied users and non-satisfied users are above 1 indicates that, for each of the methods, most users are satisfied. This does not seem very surprising, since people will use a method mostly when they are to some extent satisfied with it. However, we have to realize that the figures include respondents that have used a method, meaning that they are currently not using it anymore. Hence, satisfaction is not as obvious as it seems. As the ratios indicate, there does not seem to be a connection between the number of respondents that use a method and the level of satisfaction: the ratios are not higher for methods that are used more often.

When we look at tools, the results are to a large extent similar to those of methods (see Figure 2). Again it are general tools that are used most widely: e-mail and chatting (241 / 317 = 76.0%), search engines and web crawlers (223 / 317 = 70.3%), and catalogues (161 / 317 = 50.8%). The relatively large 20% drop between search engines and catalogues implies that e-mail and search engines are clearly the most widely used tools. When we look at the bottom of Figure 2, we can see that the least used tools are: intelligent agents (15 / 317 = 4.7%), mind mapping software (21 / 317 = 6.6%), and expert and decision support software (25 / 317 = 7.9%).

As for the methods, the ratios of satisfied and non-satisfied users are all above 1. Remarkable are the high satisfaction rates for e-mail, extranets, and mind/knowledge mapping software. The latter two are particularly interesting since they are not widely used. Rather, it seems that they are used by a selective group of satisfied users.
Additional observations can be made when Figures 1 and 2 are compared. The figures illustrate that methods are used more frequently (1855 in total) than tools (1451). I suspect that, in practice, the difference is probably even higher than these number express since more types of tools (17) than types of methods (15) were included in the survey. Thus, while there was a bias in the survey to get a higher score on tools, the score on methods was highest.

Another difference is the larger spread of methods that is used compared to the frequent use of only a small set of tools. For example, the three best scoring methods add up to 685 / 1855 = 36.9% of total usage, while for tools this number is 625 / 1451 = 43.1%. We can also see this in the steeper curve in Figure 2 compared to Figure 1.

When we compare the satisfaction ratios for methods and tools, it appears that the variation in ratios for methods is less than for tools: For methods the values lie between 1.80 and 9.77, with an average of 4.83, and for tools the values lie between 1.40 and 20.90, with an average of 5.48. This implies that, while there are some tools that score extraordinarily high on satisfaction, this is not the case for methods. It also implies that, on average, one-sixth of the users is not satisfied.

The results for the questions as to what extent most of the MTs of a company were specifically developed for the company or for the field are presented in Figure 3. This figure clearly indicates that the MTs that HTSMEs use are not specifically developed for them or for their types of companies. This observation is consistent with the results of Figures 1 and 2 where general types of methods and tools were the most used ones.
Figure 3 Extent to which methods and tools are specifically developed for company or field

As mentioned in Section 2, respondents were also asked why they did not use more specific methods and software for the identification, acquisition, and utilization of external customer/market knowledge and technological knowledge. The results for these questions are presented in Figures 4-6.

Figure 4 Reasons for not using methods and tools more often for knowledge identification

Figure 5 Reasons for not using methods and tools more often for knowledge acquisition
From Figures 4-6 we can derive the following results: Firstly, it is apparent that ‘Not being aware’ is the most important reason for not using specific MTs, regardless of EKI stage and type of knowledge. The figures also show that ‘There are too many’ and ‘They are too complicated’ are the least important reasons, regardless of EKI stage and type of knowledge. Another observation is that ‘Too expensive’ scores higher than ‘Not suitable’, regardless of stage and type of knowledge. This indicates that for HTSMEs, the price of MTs is a larger barrier against MT usage than the suitability of these MTs.

Moving from identification, via acquisition, to utilization, we see that the reason ‘No need for it’ increases in importance, compared to the other reasons. This indicates that HTSMEs perceive a higher need for MTs for identification than for acquisition and utilization.

Concerning the category ‘Other reasons’ the reasons that were given most frequently were ‘No time’ and ‘Company too small and/or specific’, which both could be coded as ‘No need for it’ or ‘There are no suitable ones’.

In general, we can see that when moving from identification, via acquisition, to utilization, the numbers decrease. However, I suspect this has more to do with a decrease in response because of repetitive questions than with any other reason. Also, the fact that the numbers for customer/market knowledge are lower than for technological knowledge have to do with the fact that more respondents filled out the questionnaire for technological knowledge than for customer/market knowledge (respondents could choose, based on their expertise).

4. CONCLUSION
This paper started with three related research questions: 1) To what extent are a variety of existing MTs used by HTSMEs? 2) What is the level of satisfaction with these MTs amongst HTSMEs? 3) What are the causes for a low usage of MTs amongst HTSMEs?

Concerning the first question, the results have shown that the extent to which MTs for EKI are used by HTSMEs varies substantially, dependent on the particular MT. Figures 1 and 2 indicate that the usage of general, relatively low-profile methods and tools is high and that the use of more specific and complicated MTs is low. Also, the figures show that methods are used more than tools and that the MTs they use are usually not developed especially for their firm or field. This is also what we might expect from HTSMEs, as they usually don’t have
the money or expertise available for investing in highly specialized tools or methods. Compared to existing research on HTSMEs use of MTs, this answer to the first research question refines the general observation that HTSMEs hardly use MTs for EKI. Also, I think that particularly the usage of methods is in general not as low as we might have expected. For example, Figure 1 shows that approximately every seventh company has appointed a knowledge manager. I think this is a very high number for such an expensive measure. Nevertheless, the results do confirm the observation that specific tools and methods are hardly used by HTSMEs.

The second question concerned the satisfaction level of MTs. From Figures 1 and 2 we can conclude that, in general, most users are satisfied with the MTs they use or have used. However, on average, approximately one-sixth of the users of an MT is not satisfied. From the figures we can also conclude that higher usage is not associated with higher satisfaction. Rather, there seems to be no connection between the usage and satisfaction rates. Finally, there are some tools where an extraordinary large share of users is satisfied: e-mail and chatting, mind mapping, and extranets.

With respect to the final research question, the results in Figures 3-6 show that ‘Not being aware of MTs’ is the most important reason for not using them, followed by ‘Not thought about’ and ‘No need for it’. Reasons for not using MTs that were hardly mentioned are that the MTs are too complicated, or not suitable for HTSMEs, or that there are too many MTs to choose from.

5. DISCUSSION
This final section of this paper will discuss the implications of the answers given to the three research questions for research and practice.

For practice, the main implication of these results concern the question as to how the usage of MTs for EKI can be increased amongst HTSMEs. A question that should precede this question is whether an increased use is desirable. Considering the answers given to the three research questions, I think this second question should be answered confirmatively. The results show that most users are satisfied and that the most important reasons for not using MTs is that companies are not aware of any or have not thought about it. Hence, it appears that the low usage of MTs amongst HTSMEs is not caused by some general defect in MTs, but more by a lack of awareness and knowledge amongst HTSMEs.

In order to increase the usage of MTs by HTSMEs it is thus important to increase HTSMEs’ awareness of MTs and to improve the accessibility and publicity of MTs. One potentially fruitful way to do this is by means of an Internet portal. Such portal can aggregate and give access to a large number of MTs and their suppliers. It can even provide a diagnosis of problems and a matching of MTs with these problems. An example of such portal is http://kinx.socintec.com.

Since the Internet is a passive medium, only developing an Internet portal is not sufficient. Additionally, it is necessary to create active and targeted communication towards HTSMEs to make them aware of the existence of such portal, or more general, to make them aware of the existence of potentially useful MTs. As they are generally well-known and well-connected to HTSMEs, SME agencies, innovation centres, and industry associations seem to be amongst the most appropriate institutions to deliver such communication. Should communication not be sufficient, such institutions can also provide training that make managers of HTSMEs’ better aware of EKI as an important process and of the opportunities that MTs provide to support this process.

Given the relatively high satisfaction rates of those HTSMEs that use particular MTs, improving the quality of the MTs themselves seems of less importance. Since price was
mentioned to be a more significant barrier for the use of MTs than suitability, it seems more important to lower the prices of existing MTs. This does not only include the price of purchasing the right to use a particular MT, but also the price of implementing, maintaining, and using it. While suppliers of MTs have of course a major role in this, I expect that the institutions mentioned above can also play an important role here. For example, as representatives of HTSMEs, such institutions should be able to negotiate with suppliers of MTs. One could think of arranging collective licences for a number of HTSMEs together.

In addition to these implications for practice, this paper has also implications for further research. The paper has not only answered questions, but it has also generated new questions. As the current study has made a broad inventory of the usage of MTs by HTSMEs, it seems useful that further research consists of in-depth analyses of MTs usage an non-usage. Therefore, future research should have a closer look at MTs that have a high usage rate and MTs that have a high satisfaction rate. Questions that need answers are: What makes these MTs so good or suitable? Why are they used? and How are they different from MTs with low usage and satisfaction rates?

Also, future research should further investigate the type of companies that use and are satisfied with particular MTs. It might be not so much the type of MT that explains usage, but more the type of company that uses the MT. In order to investigate this, a comparison should be made between, for example, companies of different sizes, ages, and industries.

Finally, since it appears that satisfaction and usage do not seem to be closely related, the question arises as to what does explain usage? We get some hints from the reasons for not using MTs, but further research is needed here.

ENDNOTES

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The role of KIBS in knowledge commercialisation

Kari Laine
Satakunta University of Applied Sciences
Faculty of Technology and Maritime Management
Tekniikantie 2, 28600 Finland
kari.laine@samk.fi

Abstract
In this paper the role of technology based knowledge intensive business services (KIBS) in commercialisation of knowledge is examined. The paper is written from the point of view of innovation management and the paper is based on a broad conception of innovation. In this conception innovations are embedded in social activities, there are many kind of innovations besides radical technological innovations, innovation is closely linked to learning, tacit knowledge has an important role in innovation, innovation is a complex process, innovation diffusion is important in addition to innovation creation, and innovation is a collective undertaking and networks are essential for it. A case study of a technology based KIBS firm started in 1997 in the incubator of Satakunta University of Applied Sciences (SAMK) is used to bring the theory to practice. The development path of the firm is described as a process and the links to the above factors will be addressed.
Background and theories in use

Universities have a new role in commercialisation of knowledge, considered as “second revolution” (Etzkowitz 1998). It began with science parks and increased collaboration in 1980’s and with other forms of commercialisation broadened to licensing and spin-off creation in 1990’s. In spin-off creation also students became involved (Rasmussen et al. 2006). Commercialisation has led to a situation where a complex web of relations exists between higher education, spin-offs created by them and large firms. All together the “commercialisation of knowledge” connects the higher education to the users of the knowledge (Etzkowitz 1998). The rise of knowledge based society also brings creation of knowledge intensive firms into the focus. The aim of the paper is to create more understanding how small technology based KIBS firms can have a new role in knowledge commercialisation. However, the innovation chain has to be managed as a whole. In this paper, the innovation chain is considered as a continuum from basic research through applied research to product development and finally commercialisation. There still exists a valley of death between research and commercialisation (Markham 2002). Spin-offs are one means to cross it.

The innovation process consists of searching, selecting and implementing which are all closely connected to learning (Tidd et al. 2005). New business opportunities are based on co-creation of value and discontinuities, in many cases on a combination of many discontinuities (Prahalad and Ramaswamy 2004, Hamel 2000, Tidd et al. 2005). Sources of discontinuity include new markets, new technology, new political rules, mature industries run out of road, new market behaviour, unthinkable events, new business models, new regulation or deregulation is done, systemic changes, architectural innovation (Bessant et al. 2005). Idea screening and concept development, the fuzzy front end of the new service development process is less fuzzy if customer interactions occur already in this phase (Alam 2005).

Innovation capability can be targeted in four ways: products, processes, positioning and paradigm. This “innovation space” gives also a model for innovation project portfolio management. (Francis and Bessant 2005). Innovations can also be divided as incremental, radical, continuous and discontinuous innovations. Systemic innovation is a combination of these, like using new technology in a new process and simultaneously rethinking the role of organisation. Systemic innovation is many times required in adaptation of innovation to make innovation desired (Saranummi et al. 2005). Successful innovation also requires integration and management of the whole innovation chain (Tidd et al. 2005). Research suggests that the entrepreneurs should concentrate more on organisational and market innovativeness than on technological (Gans and Stern 2003). Increasing knowledge focus is one way for the entrepreneur to stay on the growth path (Salojärvi 2005).

Innovation is a social process. It involves people meeting and sharing ideas. There are several types of innovation networks including a new product or process development consortium, sector forum, new technology development consortium, emerging standards, supply chain learning, cluster and topic network. Different types of networks can be used when targeting to different types of innovations. Operating an innovation network is difficult. Success factors for innovation networks are the following: partners with wide range of disciplines, science partners as universities, and access to investors and proactive management. Some of the challenges are: how
to manage something which is not in total control, how to operate on system level, how to build trust and shared risk taking without contracts and how to avoid free riders and spillovers. Configuring innovation networks must be in balance with innovation targets. (Tidd et al. 2005).

Dominant logic limits the ability to see new business opportunities. (Prahalad 2004). Focus should be on next practices, not on best practices. Low cost experimentation is needed to show the true potential of ideas (Prahalad 2004, Hamel 2000). Fast learning and articulation of experiments are needed. Firms must look beyond borders of industries and look beyond geographic borders and see exciting discontinuities instead of disruptive changes. Discontinuities challenge the dominant logic (Schumpeter 1950). Seeing forward, forecasting, is considered to be one of the main competencies of the strategic thinking (Major et al. 2001, Major 2003). There are two usual mistakes in forecasting: the change is estimated to be faster than what will happen in reality and the impacts of the change are underestimated (Mannermaa, 2004).

Peripheral vision is a part of learning. The process consists of the sequential parts: scoping, scanning, interpreting, acting and learning and adjusting. Learning and adjusting affect mental models. To improve interpretation, appropriate channels have to be created to share and interpret information internally and externally. Frequent and free dialogue should happen spontaneously. It requires culture of trust, respect and curiosity. It must also be noticed that sharing information is important (Day and Schoemaker 2004). Scanning of environment must be active, because passive scanning tends to reinforce old beliefs. This is because the information comes mostly from known sources. Successful entrepreneurship requires not only analytical, but also creative and practical intelligence, which all together constitute successful intelligence (Sternberg 2004). Knowing what is not enough and knowledge have to be turned to action (Pfeffer and Sutton 1999). Prior knowledge affects the ability to recognise the value of new information, assimilate it and apply it commercially. This is called absorptive capacity. Learning and problem solving are close to each other. “Problem solving skills represent capacity to create new knowledge”. Capability to learn is also connected to r&d. Firms that have their own r&d are also better in absorbing external knowledge. Absorptive capacity is therefore a critical part of innovation capabilities. "Ability to assimilate new knowledge is a function of the richness of the pre-existing knowledge structure” (Cohen and Levinthal 1990). Combining innovation with learning also suggests informal modes of technology transfer instead of traditional transfer models (Siegel et al. 2004). In regional context the “innovative milieu” refers to physical and socio-cultural proximity which make up “glue” that binds organisations together (Camagni 2003). Learning from customers by observing them consists of a primary feedback on which the new service and process development can be based on (Cunningham 1994).

The context in which the process is managed brings up three elements: the strategic context, the innovativeness of the organisation and the connections of the organisation with the key actors in the environment (Rothwell 1992). The implementation can be divided to several core processes and their enabling support processes (Chiesa 2001, Chiesa et al. 1996). Operating environment is becoming more and more dynamic. New knowledge, new technology and new players make the situation more complex and accelerate the change. Development of the new knowledge is a continuum. New knowledge is built on the top of older knowledge. The timing must be correct to ensure that the new knowledge can create competitive advantage (Chiesa 2005). Open innovation means that internal and external channels for idea generation and exploitation are
considered as equal (Chessbrough 2003). Even innovation can be outsourced, but it must be managed (Quinn, 1999, 2000). New forms or networking are emerging to reach continuous innovation in communities of creation and in the form of collaborative entrepreneurship (Miles, Miles and Snow 2005, 2006). Value is embedded in experiences and value is co-created with customers in interaction. There emerges a new requirement for value creation: experience network (Prahalad 2004). We are moving towards the fifth generation innovation process the key aspects of which are integration, flexibility, networking and parallel information processing (Rothwell 1994). Value is created in interaction with customers (Prahalad and Ramaswamy 2004).

Innovation diffusion is important in addition to innovation creation. There are five characteristics that may explain the success of an innovation and at least affect the rate at which the innovation is adopted: relative advantage, compatibility, complexity, trialability and observability. Relative advantage means that the innovation must offer an advantage compared to status quo. Compatibility refers to previous experiments and current needs of potential users of the innovation. The more complex is the innovation the more less likely it is to be adopted. Trialability means that there should be a possibility to try out the innovation without total commitment to it at once. There should also be visible results from the use of the innovation for the users and for those who are observing the use. There are two main challenges, to support early adopters and to win mainstream credibility. (Rogers 1983, 1995, 2003).

In the future of KIBS innovations are embedded in social activities. There are many kinds of innovations besides radical technological innovations. Innovation is closely linked to learning. Tacit knowledge has an important role in innovation. Innovation is a complex process. Innovation diffusion is important in addition to innovation creation. Innovation is a collective undertaking and networks are essential for it. (Toivonen 2004).

A case study of a KIBS firm

A longitudinal case study of a KIBS firm was implemented. The research covered a 9-year period from the start-up. The aim of the case study was to find out how the firm is connected to the value network of Satakunta University of Applied Sciences, how it manages its own innovation process (Tidd, Bessant and Pavitt 2005), how is the value network (Allee 2003) of the firm built and how the configuration of its innovation networks (Tidd et al. 2005) changed during the time the research covered. To connect the presence to the future a scenario analysis was done by using the soft system methodology (Checkland and Scholes 1990). In the research, case study principles were applied (Eisenhardt 1989, Yin 1994).

The founder of the firm was a student of Satakunta University of Applied Sciences (SAMK). The student participated in r&d projects with regional SMEs during his studies. The entrepreneur also gained knowledge from a special field of knowledge during his Bachelor thesis while he made a power system analysis a large regional company. The entrepreneur had prior knowledge from most of the essential fields of his industry field like project management, r&d, power system analysis, field of industry and code of practice in serving the field of industry. He did not have
much knowledge about running the business in practice, but he was a second generation entrepreneur and had a very entrepreneurial way of thinking.

The firm was founded in 1997 by the student at the time of graduation phase. It was the first customer firm of the incubator in the Satakunta University of Applied Sciences. There was no IP transferred to the firm in the start phase but there was both explicit and tacit knowledge transferred. The entrepreneur did not make any market research before starting the enterprise. He was convinced that his mentor has a right vision about the future of the service. The firm was totally funded by the entrepreneur himself with the help of a bank loan. The firm was started as a limited company with a minimum amount of share capital. However, during the first years the firm also made automation and electrical system design to its customers to have more income to develop the new service development. The first power system analyses were done to a regional large company in 1999. Serving new customers with analysis services started in larger scale in year 2002.

The company grew every year in turnover over 30% except that there were two unprofitable years 2003-2004 and it grew finally 63% last year. The turnover is now about 400,000 euros and the firm has six employees. The growth was not based on a single factor but selling existing services to new customers and simultaneously the development of new services have created most of the growth. The growth of the Internet created totally new business opportunities for the firm. A whole set of new services was created. The firm has also found a development partner for this. The new partner was also a firm started in the same incubator by students in the Satakunta University of Applied Sciences. In the firm one third of the personnel is developing new services and technology and about 5% of the turnover is used to new service development.

Like many small companies, this company also had many factors that hindered the development. During the first years working mainly with one major customer was hindering new business opportunity recognition and searching of new customers. The entrepreneur finally decided to leave the customer to have more time to develop the new product and seeing new potential customers. Having more customers lately made it much easier to recognize business opportunities in the context of power system analyses. “Every time I see the customer in his real environment, I see a lot of new business opportunities”. The main customer cases were all international, so the firm also gained a lot of multicultural experience. They had projects all over the world.

During the years the entrepreneur learned appropriate ways to market the services. In the beginning the contracts the firm made were not optimized form its point of view. The contracts gave too free hands for their customers to make delays in the process. In this case the new opportunity recognition changed clearly when the new software product was launched. The firm was able to have many new customer contacts with this product. The firm immediately started to recognize new opportunities with accelerated rate. New features were added to existing services and a totally new way to produce the services is under development. But still the entrepreneur needs to meet the customer in his real environment to see the opportunities. This requires trust to be created. Some of the customers are also returning customers because they have changes in their power systems and they need to update the analysis done earlier. The entrepreneur says that renting office space and special laboratory equipment from SAMK was essential for his start up.
Later also the expertise support from the SAMK was important because of the complex nature of the service.

In a technology based firm the correct timing is essential. The entrepreneur must be able to meet the right people at the right time and to have the courage to start the business with a high level of risk. Also funding the development is a challenge. In this case other services, like electrical and automation engineering, were used to create income to finance the development. During these projects the firm also gained multicultural experience. External funding was not needed. The entrepreneur even occasionally worked in another firm to have personal income during the first two years. Flexible risk funding for starting KIBS would be useful.

There was a strong supporting role from the Satakunta University of Applied Sciences in the beginning and during the whole development path until today. The support has not included any financial support. The support was in management, strategic thinking and technology development. Proximity to higher education has helped significantly. The entrepreneur has been able to use students in r&d projects in his firm. Also the new employees graduated from the same place than he did. Expert support has been available during the whole development period.

The best customers act as a development partner for a small firm. Although at the moment there are no immaterial property rights owned by the firm, in the future it may be one of the key issues. In a small firm, whether knowledge based or not, small things matter. The entrepreneur must stay focused all the time and still unexpected events can change the whole promising success story. The start of a spin-off may be based on regional needs, but the most promising companies will grow to at least national level players.

In the Satakunta region the hundred new firms created in the same incubator form a new cluster of knowledge intensive firms. Many of the firms are in close co-operation with existing firms in the region increasing the competitiveness of them and creating added value of their customers. There is a strong national policy to create spin-offs from higher education. However, in 1997 it was not common to motivate students to start their business during the studies in university. At that moment Satakunta University of Applied Sciences already had a policy to create spin-offs started by students. This has been proven to be a success for the region and a positive image builder for SAMK. Innovative new firms also collaborate in large r&d projects administered by SAMK. This is one way to upgrade their knowledge and make them more embedded in regional clusters. Picture 1 describes the value network of a typical large r&d project administrated by SAMK.

Firms form their own networks for innovation and service development. In Picture 2 the value network of the case firm is described. It is a simplified model where only the most important value adding transitions between the key actors are marked. There are several industrial partners for new service development. The regular customers fund the service development.

In Picture 3 the innovation chain is modeled. The chain begins with active searching. In search the entrepreneur was able to exploit external connections effectively. The firm has a flexible strategy with a vision of “Total power system analysis”. All development efforts are leading to that direction. The strategy changed many times according to new customer needs detected,
dominant changes in environment and unexpected events. The implementation was effective from the very beginning of the firm because the entrepreneur had experience from r&d. The entrepreneur used time to evaluation and reflection of experiences. Innovativeness was built in the organization by doing constantly small improvements to services. Learning required a combination of knowledge from several sources including also tacit knowledge.

In picture 4 the innovation network transitions are described. In the beginning the firm was helping other tenants in the incubator. The firm was also introduced to local clusters by the mentor. The entrepreneur himself started strategic partnership with industrial clusters. The next step is an option for heterogenous innovation networks depending on the success of the ongoing service and process development. There was a simultaneous use of all the networks so that beginning of a new network did not mean the end of previous networks. In 2006 three future scenarios were built for the firm by scenario analysis using the soft system methodology. The analysis revealed that the entrepreneur has possibilities to choose between different development paths. Business as usual leads to strong position in Finnish markets but focusing on a specific area of services gives possibilities to grow international.
In 2006 three future scenarios were built for the firm by scenario analysis using the soft system methodology. The analysis revealed that the entrepreneur has truly possibilities to choose between different development paths. Business as usual leads to a strong position in Finnish markets but focusing on a specific area of services gives possibilities to grow international. Possibilities to exploit these new directions require success in ongoing development projects. It looks like there are much more opportunities than true possibilities to exploit them. Systemic innovation gives possibilities to adjust the dimensions of innovation so that adoption comes more manageable.
Picture 2. The value network of the case firm.

<table>
<thead>
<tr>
<th>Innovative organisation (constant improvements, small steps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic context (vision of “Total power system management)</td>
</tr>
<tr>
<td>External connections (industrial partners, SAMK)</td>
</tr>
</tbody>
</table>

Table 1: The model of the innovation process of case study firm (developed from Tidd et al. 2005, p. 89).

Picture 3. The model of the innovation process of case study firm (developed from Tidd et al. 2005, p. 89).
Discussion and implications from the research

The entrepreneur had rich prior knowledge structure and it helped him to have a high absorptive capacity. The absorptive capacity was further improved by r&d competence. Probably due to the high absorptive capacity the entrepreneur was able to actively scan the business environment and technology knowledge. He was able to perceive forthcoming changes from weak signals and he was able to start new service development just in time. He was even able to create added value for the customers with the dominant changes. He also was able to challenge the dominant logic on the field. The firm also added the absorption capacity of two local clusters by transferring knowledge to them.

The entrepreneur was able to transfer tacit component of knowledge in several occasions. He was also able to make low cost experimentations to prove the concepts created. He was able to manage the whole innovation chain and make implementation effective. Customers were connected to development projects in application phase, not too early or too late. The entrepreneur had strategic approach to new service development. He was able to identify his weak points so that he could search for expert support on those fields. The entrepreneur sustained connections to the original source of the knowledge, SAMK, all the time. The development steps have been small enough to ensure success in development, rapid service development and fast feedback from customers for double loop learning.
The entrepreneur was not able to commercialise knowledge alone, but he was able to create a value network to support service development and commercialisation. He was able to manage the value network without excessive contracts. He was able to prove the advantages of the service with support materials. The services were divided to easy-to-try parts to add the trialability of the services and to accelerate the diffusion among potential users. Although the theory and process is complex the service itself was easy to understand. The results of the service were observable. He was able to support early adopters and with references he earned the credibility of the mainstream users of the services. The entrepreneur was highly successful in building social networks. He embedded deeply in local clusters in the early phase of his entrepreneurship. He also had successful intelligence and concentrated more on markets than on technology itself. He used primary feedback from his customers to develop new services.

The implication from this case study for a small firm is the selection of partners. The customer partners could give insights to the industry and help in recognizing the new business opportunities. They can also co-develop the new services or products (based on their needs), pilot the new services and offer a test platform for them.

The implication to the regional development policy is a service development support for small KIBS when they commercialise knowledge from higher education. When supported, the KIBS firms could create many innovative services for regional traditional industry clusters. These innovations are necessary for traditional industry to ensure its competitiveness. The support should only be used for product and service development and networking, not for providing the services.

Implication to the higher education is to increase the embedding of small KIBS. Units of higher education can help in creating the regional embedding, in networking, in recognition of the technology trends and in scanning new research knowledge and in giving expertise support. This includes creation of networks and any kinds of action that increase the interaction with other regional clusters. They can also help in original opportunity recognition, in business planning and strategic thinking. The incubator should be able to resource a mentor for all tenants. However, every case is its own. Much depends on the mentor and the firm itself. The research also brings up the question of strategic and expert support. Renting the special equipment for small firms lower the threshold to launch new services based on the use of this sophisticated equipment. In many cases an incubation process is essential to provide effective services for the entrepreneurs.

KIBS are one channel to commercial knowledge from higher education. Most of the commercialization is still done by customer firms after collaboration projects when they use transferred knowledge or technology in new services or products. However, KIBS are an important channel because they add the dynamics of the regional economy and offer opportunities of entrepreneurship for the students. The KIBS firms may also be interested to commercial knowledge which is not seen important by existing firms. For higher education the KIBS create a live connection to users of knowledge when the interaction is further developed after the launch of the firm. The interaction also opens a whole spectrum of opportunities for research. The future research will concentrate on the beginning of the innovation process of KIBS firms.
Acknowledgements

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Tekes, Helsinki.


PROJECT MANAGEMENT TOOLS AND TECHNIQUES IN HIGH-TECH SMES IN IRELAND

Alan Murphy, Ann Ledwith

Department of Manufacturing and Operations Engineering
University of Limerick
Limerick
Ireland

Tel: 353 61 213271
Fax: 353 61 338171

Email: alan.murphy@ul.ie
      ann.ledwith@ul.ie

Enterprise Research Centre
University of Limerick
Limerick
Ireland
Abstract

In Ireland today and across Europe, Small-to-Medium Enterprises (SMEs) account for 99% of activity on the market (European Communities 2003). However, with particular emphasis on manufacturing in Ireland, it is widely accepted that economic changes are leading to increased international competition from Asia and Eastern Europe. This fact added to issues of increasing globalisation and customer demands changing ever more rapidly has resulted in increased pressure on the SME. Organisations need the ability to manage projects on time, within budget and to specification in order to remain competitive and survive.

Project management is a well-established discipline defining in considerable detail the tools and techniques that are required to define, plan and implement any project. However, while many researchers have addressed the issues surrounding the management of projects within large firms (White and Fortune (2002); Bryde (2003)) there has not been a lot published to date about the management of projects in SMEs.

This paper examines previous empirical studies on Project Management implementation in various industry sectors and the criteria and factors most frequently adopted. The paper also examines the results of a survey distributed to over 100 Owner / Managers of High-Tech SMEs in Ireland that attempts to recognise the general characteristics of projects undertaken by SMEs, the issues they encounter and their opinions on how SMEs can achieve greater efficiency and competitiveness. The results will contribute to the development of a simplified process of Project Management suited to the needs of the SME.

1.0 Introduction

SMEs ranging from the dynamic, innovative and growth-oriented to the traditional enterprises satisfied to remain static are imperative to the economy as the engine of economic and social development Hallberg (1999). Floyd and McManus (2005) while examining the increasing significance of small firms in the EU, highlighted this fact by stating that increased importance has been given to SMEs with regards to industrial policy of the EU. According to the European Competitiveness report of 2003, SMEs account for 99 per cent of activity in the EU.

The potential threat to existence of SMEs leads to the conclusion that they need to increase their competitiveness and quality to match the competition. One innovative step that can enhance the chances of progression in SMEs is the introduction of the process of Project Management.

Project management is well established with White and Fortune (2002) describing it as a well developed and well accepted area of professional expertise and an area for academic research aimed at encouraging improvement in a system. Project Management offers a systematic approach to all stages of a project by ensuring that every step is carefully planned, monitored and accounted for.

Although initially intended for application in large organisations with complex systems that require such a process Baccarini (1999), modern methods of project management can be adapted and altered to suit the needs of the smaller organisations.
It is not only a process but a mindset also. Owners or senior management of SMEs must be open to its potential towards progression before it can be introduced as a beneficial process within the organisation.

This paper aims to provide the necessary information, gathered through a survey of over 100 SMEs, to develop a Project Management system based on existing tools and techniques to meet the needs of SMEs in producing and achieving credible project management plans.

2.0 SMEs: Characteristics and impact on the economy

The definition of SMEs has varied over time with some believing there has been a lack of homogeneity in their categorisation, (McAdam, Reid et al. 2005). For the purpose of this research, reference will be made to the definition set out following the European Commission recommendation on May 6th 2003 and that took effect on January 1st 2005. Table 1 below outlines the key aspects of the new definition as recommended by the European Commission.

Table 2.1: The new thresholds implemented by the European Commission on January 1st 2005

<table>
<thead>
<tr>
<th>Enterprise Category</th>
<th>Headcount: Staff</th>
<th>Annual Turnover</th>
<th>Annual Balance Sheet Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium – Sized</td>
<td>&lt; 250</td>
<td>≤ €50 million</td>
<td>≤ €43 million</td>
</tr>
<tr>
<td>Small</td>
<td>&lt; 50</td>
<td>≤ €10 million</td>
<td>≤ €10 million</td>
</tr>
<tr>
<td>Micro</td>
<td>&lt; 10</td>
<td>≤ €2 million</td>
<td>≤ €2 million</td>
</tr>
</tbody>
</table>

When researching the general characteristics of SMEs, comparative analysis with larger organisations helps to provide a clearer image of their standing in the market. SMEs exhibit both advantages and disadvantages when compared to larger organisations. Audretsch, Prince et al. (1998) in their comparative paper examining small and large firms identified key issues surrounding the SME. Small firms have a greater potential flexibility and closeness to the customer and an edge towards customisation and innovation. They seek out markets where their advantages count and they are not in direct competition with their larger counterparts.

However, they continue to state that despite these key advantages, SMEs lack economies of scale, scope and learning. Edwards, Delbridge et al. (2001), outline that SMEs exhibit behavioural features that give them an innovative advantage over large firms that include the ability to respond rapidly to external threats or opportunities, have more efficient internal communications and exhibit interactive management cycles. Rothwell (1992) makes reference to SMEs in their attempts to progress by stating that, ‘SMEs are thought to lack the material and technological resources that enable large firms to ‘spread risk over a portfolio of new products’ and ‘fund longer-term R&D’.

Table 2 highlights some of the key differences between SMEs and large organisations as suggested by (Ghobadian and Gallear 1997).
Table 2.2: Key differences between SMEs and Large organisations (adapted from Ghobadian & Gallear, 1997)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SMEs</th>
<th>Large organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td>Few or no layers of management</td>
<td>Several layers of management</td>
</tr>
<tr>
<td></td>
<td>Top Management close to the point of delivery</td>
<td>Top Management far from point of delivery</td>
</tr>
<tr>
<td></td>
<td>Low degree of specialisation</td>
<td>High degree of specialisation</td>
</tr>
<tr>
<td></td>
<td>High incidence of innovativeness</td>
<td>Low incidence of innovativeness</td>
</tr>
<tr>
<td><strong>Procedure</strong></td>
<td>Low degree of standardisation</td>
<td>High degree of standardisation</td>
</tr>
<tr>
<td></td>
<td>Low degree of formalisation</td>
<td>High degree of formalisation</td>
</tr>
<tr>
<td></td>
<td>People dominated</td>
<td>System dominated</td>
</tr>
<tr>
<td></td>
<td>Idealist decision making</td>
<td>Fact-based decision making</td>
</tr>
<tr>
<td><strong>Processes</strong></td>
<td>Simple Planning &amp; Control system</td>
<td>Complex planning &amp; control system</td>
</tr>
<tr>
<td></td>
<td>Informal evaluations &amp; reporting</td>
<td>Formal evaluation &amp; reporting</td>
</tr>
<tr>
<td></td>
<td>Result orientated</td>
<td>Control orientated</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>High degree of resistance to change</td>
<td>Low degree of resistance to change</td>
</tr>
<tr>
<td></td>
<td>Corporate mindset</td>
<td>Departmental mindset</td>
</tr>
<tr>
<td></td>
<td>Modest capital &amp; financial resources</td>
<td>Abundant capital &amp; financial resources</td>
</tr>
</tbody>
</table>

An examination of the skills of project managers in small and large electronics firms in Ireland (Ledwith 2004), showed that project managers in small firm were weak in the areas of motivation, marketing and management. Small Irish firms demonstrated limited use of project management techniques and were not benefiting from project management in terms of increased new product success. Despite this it was observed that by improving project planning, establishing clear priorities and setting clear objectives, small Irish firms could improve NPD performance by reducing project delivery times.

Statistics gathered by the Programme for Industrial Interface (PUII) in the University of Limerick shows that 95% of the trading entities and 80% of employment are made up by the SME. Günter Verheugen of the European Commission declared that: ‘Micro, small and medium-sized enterprises (SMEs) are the engine of the European economy. They are the essential source of jobs, create entrepreneurial spirit and innovation in the EU and are thus crucial for fostering competitiveness and employment.’ European Commission Publication (2005).

The economical importance of SMEs is also highlighted by (Floyd and McManus 2005) who identified examples of SMEs improving the competitive position of the EU:

- Small firms have fewer problems with labour relations than their larger counterparts.
- Small firms offer the benefit of being able to change production quickly.
- Small firms can offer personalised service, differentiating business activity.

Despite their strong potential as a driving force within Europe, SMEs are suffering from the effects of inflating running costs and external competition. Due to the lack of depth they possess in comparison to large organisations, the rising international economic threat posed by Asia and Eastern Europe can have overwhelming consequences for SMEs.
The Irish Small-to-Medium Enterprise Association (ISME) trends surveys reflect the economic effects on SMEs in Ireland over the last two years:

- **4th Quarter 2004**
  - Manufacturing sector reporting a significant recovery with one fifth of companies anticipating future job creation.
  - Business Optimism, employment creation and investment levels provide a positive platform for future development and growth in the SME sector.
  - Business costs continue to be a burden for SMEs
  - 19.3% of businesses report that sales/order books were below normal for the period.
  - Labour costs identified as the biggest threat to SME development and growth as confirmed by 23% of companies.

- **3rd Quarter 2005**
  - A report on areas of concern for SMEs shows the following breakdown:
    1. Labour Costs – 25%
    2. Erosion of competitiveness – 19%
    3. Economic uncertainty – 12%
    4. Reduced orders – 11%
  - A net decrease of 3% in exports represents a sharp reduction on previous quarters and indicates that the reduction in competitiveness is starting to impinge.
  - Reality on the ground shows that companies are finding it increasingly difficult to operate due to the high cost environment and external competition.

Issues seen in the trends surveys along with other issues mentioned sufficiently justify the need for SMEs to consider new methods to enhance their ability to compete and to grow.

### 3.0 Projects and Project Management:

#### 3.1 Projects

Any task undertaken that is specific, unique and with a specific aim to achieve it can be considered a project. PMI (2000) define projects as ‘a temporary (definitive beginning and definitive end) endeavour undertaken to create a unique (projects involve doing something that has not been done before) product or service.’ Kerzner (2001), through his book on Project Management outlined the key characteristics of projects:

- Projects are the change efforts of society and the survival of organisations in the modern environment is through effective management of change efforts.
- The Project is not synonymous with the product of the project. The project is the process by which the product is produced and has a finite life.
- Projects comprise of activities that are usually non-repetitive and inter-related.
- Projects involve multiple resources (human and non-human) that require close co-ordination.
Projects can be considered as the achievement of a specific objective and involve the utilisation of resources on a series of activities or tasks. (Munns and Bjeirmi 1996) in their paper on how to achieve project success, differentiate between project success and project management success. The definition of a project suggests an orientation towards higher and longer-term goals such as return on investment, profitability and competition, while project management focuses on short-term goals and a more specific context for success. Cooke-Davies (2002) proposes the distinction between project success and project management success:

- **Project Success** is measured against the overall objectives of the project,
- **Project Management Success** is measured against the widespread and traditional measures of time, cost and quality.

Munns and Bjeirmi (1996) conclude that despite the differences between project success and project management success they compliment each other. A project can succeed despite the failure of project management but successful project management implementation can increase the potential for success on an overall project scale.

### 3.2 Project Management: Definition and Principles

Project Management has existed, in theory, for centuries with its informal application by the Chinese and Egyptians with such feats as the Great Wall of China and the Pyramids. However, modern Project Management is a recent phenomenon gaining initial acceptance in the rapid development of the Information Technology industry, (Fox 2004).

Cicmil (1997), in a paper on critical factors of effective project management suggested the following:

‘In any project situation, there is a client/customer who has a unique need which requires knowledge and resources to conduct the realisation of the concept within the specific constraints of time, money and specification. The effective management processes of planning, monitoring and control are required to translate the idea of change into tangible deliverables.’

PMI (2000) supplied a simplified definition as ‘the application of knowledge, skills, tools and techniques to project requirements.’

The emergence of modern project management owes to three core stimuli, (Baccarini 1999):

1. **Complexity** – Growing complexity of tasks and a need for a greater degree of specialisation.
2. **Change** – Increasingly dynamic environments with constant pressure within organisations to implement change due to global competition.
3. **Time** – Demand for tasks to be completed as quickly as possible.

Project Management is an innovative process whose implementation is increasingly necessary in today’s competitive market. Undertaking any project now involves overcoming many obstacles (Kerzner 2001) that include project complexity, client special requirements, organisational restructuring and project risks. With a systematic process in place, such as Project Management, obstacles can be accounted for and actions or measures taken to either prevent or overcome them. Some of the many potential benefits project management provides as proposed by (Kerzner 2001) include:
Essentially, project management is the planning, organising, directing and controlling of an organisation’s resources to achieve a relatively short-term objective. Over its course, modern Project Management as a discipline has emerged and has been constantly remoulding itself to allow for expansion in its practice. A valuable conclusion was made by (Crawford, Pollack et al. 2005) who carried out a study of the International Journal of Project Management and the Project Management Journal over the last ten years to try to uncover the trends in project management:

‘As a field, project management is regularly facing new challenges, as the tools, methods and approaches to management that comprise the discipline are applied to different areas, for different ends, in different cultures.’

3.3 Project Management: Success Criteria and Success Factors

A second distinction to be recognised when studying projects and their management is the distinction between critical success criteria and critical success factors. Cooke-Davies (2002) defined the difference as follows:

**Success Criteria** are the measures by which success or failure of a project will be judged. **Success Factors** are the inputs to the management system that lead directly or indirectly to the success of the project.

This distinction is supported by (Belassi and Tukel 1996) who recommend that sound research on critical success factors have to:

1. Distinguish between success factors and success criteria.
2. Distinguish success factors within the control of the project manager and factors outside his/her control.

Determination of a project’s success criteria has become far more complex in recent times (Belassi and Tukel 1996) with the three criteria of Time, Cost and Performance no longer sufficient. On any project, there are numerous parties involved with their own perception of success. These can include the Project Manager, Project Team, Top Management, the Client and external parties from the Political and Economical environments. A project perceived as a success by a project manager and his team, might be perceived as a failure by the client. In contrast, top management might deem a project to be a failure for not meeting specifications but may still satisfy the client. Pinto and Slevin (1989) recognised this ambiguity in determining project success by stating that it is still not clear how to measure success because the parties who are involved in projects perceive project success or failure differently.
From the perspective of developing a simplified method of project management for SMEs, it might be necessary to consider the perception of success from one party, namely senior management based on their overwhelming influence in SME procedures.

Research has contributed to a significant quantity of factors that could be described as critical to a project's outcome. But projects are individual and unique and lead to the understanding that success factors can differ between them. Belassi and Tukel (1996) proposed that, ‘a combination of many factors, at different stages of the project life cycle, result in project success or failure’. Table 3 outlines the key success criteria and success factors seen to be most significant from previous empirical studies.

<table>
<thead>
<tr>
<th>Author</th>
<th>Success Criteria</th>
<th>Success Factors</th>
</tr>
</thead>
</table>
A trend emerges in Table 3, the three basic criteria of time, cost and quality appear regularly. Additionally, client satisfaction was deemed as significant and must be an objective to achieving overall project success. Westerveld (2003) factored in the appreciation of the various parties involved both directly and indirectly on the project but may lead to issues of conflict when determining whether a project was successful or not. The critical success factors uncovered many varying factors that could be implemented and used as a tool for success. Before considering these factors, it is important to reiterate that SMEs are generally characterised as having basic organisational structures with simple planning and control systems in place. Therefore, a new process of project management for SMEs would be more beneficial as a simplified methodology with specific reference to selected focus on key factors. Having reviewed the factors considered above, six were highlighted as having the greatest potential influence:

- Top Management Support
- Clear Goals / Objectives
- Planning, Monitoring & Control
- Resource Allocation
- Risk Management
- Client Consultation

The factors above are considered to be ‘critical’ to successful implementation of project management on projects and can be with the correct approach, can form part of a process suited to SMEs. All six factors form a question in the empirical study to seek the opinions of SME owner – managers as to their significance or importance in undertaking a successful project.

**4.0 Empirical Study Methodology**

**4.1 Questionnaire Design**

A questionnaire was developed as the first stage towards the development of a new project management framework for SMEs in Ireland. The main objectives in developing the questionnaire were to explore the following:

1. Current structures in place such as organisational structure and decision-making authority.
2. The level of importance placed on projects, the basic characteristics of projects (level of investment, duration and staff delegation) and perceived success of projects to date.
3. The level of recognition of Project Management as a process in SMEs that includes implementation and associated techniques, and general opinions of its potential as a process.
4. Criteria used to base success upon and factors implemented to achieve success on projects.
5. Opinions towards future methods of project improvement in SMEs and reasons behind lack of research in the area.

With the focus being placed primarily on High-Tech SMEs, organisations in the industry sectors of Medical Devices, Electronics and Telecommunications were sought. High-
Tech SMEs were considered more relevant to the survey as they are more likely to contain relatively complex production systems and would find the process of project management beneficial and in some cases, necessary. The Kompass website, providing general information on organisations across Ireland was used as the source for the collection of organisations to be included in the distribution list. Selection of SMEs from the database was dependent on two factors: Number of Employees and Industry Sector. With reference to Table 1, any organisation with an employment level of less than 250 people was considered for inclusion. The questionnaire was piloted with two SME owner-managers. These pilot tests lead to improvements in wording, and the removal and addition of some questions. The questionnaire was distributed to over 100 organisations via email. The questionnaire was sent to the attention of owner-managers because their opinions would be most influential in SMEs. By directing it to owner-managers, it could confirm or not, the opinions that they tend to be traditional in their ways and lack openness to new and innovative processes.

5.0 Results & Discussion
The research is at an early stage; only 12 responses have been retrieved to date. This section highlights the critical results found and discusses their significance.

SME Characteristics
Tables 4.1 and 4.2 present the key results of the research. Results show that the majority of SMEs operate under a matrix structure signifying recognition of the need to have a strong structure in place. This is supported by the strong agreement to the statement that organisational structure affects the management of projects.
As expected, owner-managers are most influential in the decision-making processes followed by functional managers and projects steering groups. These trends suggest the existence of traditional methods of management. Added to that, only 50% of the respondents claimed that there is a full-time project manager in their organisation. These findings put weight to the belief that owner-managers are close to all aspects of company actions and back the literature findings (Ghobadian and Gallear 1997) that little or no layers of management are in place.

Project Characteristics
The results highlight that projects undertaken by SMEs are generally small in nature with the majority of the respondent organisations spending between 0-20 percent, as a percentage of turn-over, on projects, have only 1-10 staff working on projects and project durations varying between 0-12 months but no more. However, there was majority agreement on the statement that projects undertaken are complex in nature.
Regarding the Project Life Cycle phases, most organisations are involved in all stages with the phases of Conceptual, Planning and Implementation considered most important in that order. The significance of the Conceptual phase is highlighted by the respondent organisations belief that sufficient research and analysis is carried out before undertaking a new project.
### Table 5.1 Breakdown of findings from Project-based questions

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Sector</th>
<th>No. of Staff</th>
<th>Organisation Structure</th>
<th>Project Management</th>
<th>Project Manager</th>
<th>Project Expenditure (as % of Turnover)</th>
<th>Project Staffing</th>
<th>Project Durations</th>
<th>Project Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medical Devices</td>
<td>32</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>0-20%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>3.66</td>
</tr>
<tr>
<td>2</td>
<td>Medical Devices</td>
<td>50</td>
<td>Matrix-Functional</td>
<td>Yes</td>
<td>Yes</td>
<td>0-20%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4.00</td>
</tr>
<tr>
<td>3</td>
<td>Medical Devices</td>
<td>110</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>20-40%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4.33</td>
</tr>
<tr>
<td>4</td>
<td>Electronics</td>
<td>130</td>
<td>Matrix-Functional</td>
<td>Yes</td>
<td>Yes</td>
<td>20-40%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4.00</td>
</tr>
<tr>
<td>5</td>
<td>Manufacturing</td>
<td>34</td>
<td>Matrix</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>2.00</td>
</tr>
<tr>
<td>6</td>
<td>Telecommunications</td>
<td>32</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>60-80%</td>
<td>10-30</td>
<td>3-6 months</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Engineering</td>
<td>60</td>
<td>Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Manufacturing</td>
<td>30</td>
<td>Matrix-Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Telecommunications</td>
<td>130</td>
<td>Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3.33</td>
</tr>
<tr>
<td>10</td>
<td>Manufacturing</td>
<td>85</td>
<td>Functional</td>
<td>Yes</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>3.33</td>
</tr>
<tr>
<td>11</td>
<td>Electronics</td>
<td>42</td>
<td>Matrix-Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3.33</td>
</tr>
<tr>
<td>12</td>
<td>Manufacturing</td>
<td>50</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>20-40%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Note: The scores displayed under ‘Project Success’ are the average of ratings for project success under the headings of Budget, Schedule and Performance.

### Table 5.2 Tabulated Result Sets

<table>
<thead>
<tr>
<th>TITLE</th>
<th>Res Av.</th>
<th>Level of Importance of Project Life Cycle Phases</th>
<th>Most significant success criteria</th>
<th>Most Influential Success Factors</th>
<th>Res Av.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>3.25</td>
<td>Conceptual</td>
<td>Completed within Budget</td>
<td>Clear Goals / Objectives</td>
<td>4.56</td>
</tr>
<tr>
<td>Owner - Manager</td>
<td>4.73</td>
<td>Planning</td>
<td>Completed within Schedule</td>
<td>Senior Management Support</td>
<td>4.56</td>
</tr>
<tr>
<td>Project Steering Group</td>
<td>3.88</td>
<td>Testing</td>
<td>Meets required quality standard</td>
<td>Planning, Monitoring &amp; Control</td>
<td>4.00</td>
</tr>
<tr>
<td>Board of Directors</td>
<td>2.88</td>
<td>Implementation</td>
<td>Meets specification</td>
<td>Resource Allocation</td>
<td>4.22</td>
</tr>
<tr>
<td>Functional Managers</td>
<td>3.91</td>
<td>Closure</td>
<td>Appreciation by users</td>
<td>Risk Management</td>
<td>3.22</td>
</tr>
<tr>
<td>Others</td>
<td>2.67</td>
<td></td>
<td>Appreciation by stakeholders</td>
<td>Client Consultation</td>
<td>3.63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Appreciation by project personnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Others</td>
<td>2.50</td>
</tr>
</tbody>
</table>

Note: Res. Av = The average response to the factors seen above.
Table 5.3 Levels of agreement to statements

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>Response Average</th>
<th>STATEMENTS</th>
<th>Response Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational Structure affects the management of projects</td>
<td>4.00</td>
<td>Project Management can be applied in similar fashion in SMEs as in large organisations</td>
<td>3.63</td>
</tr>
<tr>
<td>A change of organisational structure would have a positive impact on project execution in my organisation</td>
<td>3.38</td>
<td>Previous experience is a key factor to implementing an effective system of project management</td>
<td>4.13</td>
</tr>
<tr>
<td>Projects undertaken by my organisation are generally complex in nature</td>
<td>3.38</td>
<td>Sufficient research and analysis is carried out before undertaking a new project within my organisation</td>
<td>3.38</td>
</tr>
<tr>
<td>Projects undertaken by my organisation involve close collaboration with client organisations</td>
<td>3.63</td>
<td>A project can be successful despite the failure of project management</td>
<td>2.38</td>
</tr>
<tr>
<td>Projects undertaken by my organisation involve close collaboration with the suppliers</td>
<td>3.75</td>
<td>Success of projects within my organisation is mainly dependent on external factors (e.g. market demand, government regulations)</td>
<td>3.25</td>
</tr>
<tr>
<td>Large organisations approach projects in a different manner to SMEs</td>
<td>4.00</td>
<td>Success of projects within my organisation is mainly dependent on internal factors (e.g. project management, proficiency)</td>
<td>3.38</td>
</tr>
<tr>
<td>Large organisations possess advantages over SMEs in project implementation</td>
<td>3.50</td>
<td>A well defined project management process is a necessity for successful implementation of projects</td>
<td>4.25</td>
</tr>
<tr>
<td>Adequate research and facilities on best practice in the field of project management are available to SMEs</td>
<td>3.00</td>
<td>Success criteria measures used by my organisation are sufficient to determine project success</td>
<td>3.63</td>
</tr>
</tbody>
</table>

Note: A 1-5 scale was used for the statements where: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

Table 5.4 Open question responses

**How can project performance be improved?**

- Prioritisation of project tasks over other work
- Reviewing EVMS methods and honing CPI and SPI introduction of a strong matrix management structure
- By people being trained to understand the principles and benefits of same
  - 1. Training of Project Managers. 2. Clearer Goals being set and communicated to all staff involved. 3. Better client or fact finding on site at conception stage
- More control of project team

**The conception among SMEs that Project Management is too complex a process / technique to implement and is more suited to larger organisations**

- No, it can actually be easier to implement in a smaller organisation.
- No. I have worked in industries of various sizes – the approach is different but the tools are the same
- You would want to be clearly identify the benefits of it and then it may not be that complex to achieving the implementation of same.
- No, I do not agree, it is as easy to implement. It is just that in SMEs it is very difficult to afford the time and the resources….it is a growing issue for a company and a mindset.
- No, if adequate time and resources are given then there should not be any problems

Success of projects is based more on internal factors than external based on trends in statement results. ‘Clear Goals/Objectives’ and ‘Senior Management Support’ were both considered most important as factors towards success and again supports the literature. Other factors, in order of importance included, ‘Resource Allocation’, ‘Planning Monitoring and Controlling’ and ‘Client Consultation’. These results would not be considered as unusual. Resources are always an issue for SMEs and must be managed effectively, planning and controlling of projects is vital, particularly on complex projects and client consultation is critical in both the implementation and planning phases of a projects life cycle.
When compared to large organisations, SMEs agreed that there is a different approach made to projects and that large organisations possess advantages over SMEs in project implementation. These results are expected with large organisations possessing greater capital and resources and a greater degree of specialisation than their SME counterparts, (Ghobadian and Gallear 1997). When asked how they could improve project performance, respondents suggested prioritisation of project tasks over other work, more control of project team, clearer goals and communication channels and better client or fact-finding at conception stage.

**Project Management**

One interesting finding was the disagreement to the statement that projects can be successful despite the failure of project management. This signifies a belief in project management as a process of improvement and is backed by the agreement to a well-defined project management process being a necessity for successful implementation of projects. Of the respondents, 60% consider project management an identifiable process in their organisation, a substantial quantity considering the lack of research and facilities available to SMEs on project management. A variety of tools and techniques are being used (see figure 4.4) with Project Planning, Project Teams and Gantt Charts featuring most regularly. However, these tools would be considered as fundamental tools to implement and possibly show that although a system of project management is in place, it may only provide basic planning abilities.

![Figure 5.1 Project Management Tools & Techniques implemented](image)

Despite considering that SMEs approach projects differently to large organisations, a significant proportion of respondents believed that project management could be implemented in similar fashion to large organisations. The open-ended question on the subject of project management being too complex a process to implement in SMEs showed sufficient disagreement to summarise that with the right approach and allowable time, project management could be incorporated with maximum effect.
6.0 Conclusion

The findings of the questionnaire are an initial attempt to understand the current practices in SMEs in Ireland and the opinions of SMEs to the potential of project management as a process of improvement. From initial findings it is clear that despite the lack of research and facilities available to them, SMEs are clearly aware of project management and the benefits it offers but obstacles of time, money and resources can prevent its implementation. With respect to the development of a methodology suited to the needs of SMEs, experiences of respondents have shown that understanding the tools and techniques being used by larger organisations and tailoring them to suit the SME environment is the best approach to take.

Further investigation will include case studies in selected organisations to expand the existing information on SME practices required for a new framework of Project Management to be developed.

7.0 References


PROJECT MANAGEMENT TOOLS AND TECHNIQUES IN HIGH-TECH SMES IN IRELAND

Alan Murphy, Ann Ledwith

Department of Manufacturing and Operations Engineering
University of Limerick
Limerick
Ireland

Tel: 353 61 213271
Fax: 353 61 338171

Email: alan.murphy@ul.ie
ann.ledwith@ul.ie

Enterprise Research Centre
University of Limerick
Limerick
Ireland
Abstract

In Ireland today and across Europe, Small-to-Medium Enterprises (SMEs) account for 99% of activity on the market (European Communities 2003). However, with particular emphasis on manufacturing in Ireland, it is widely accepted that economic changes are leading to increased international competition from Asia and Eastern Europe. This fact added to issues of increasing globalisation and customer demands changing ever more rapidly has resulted in increased pressure on the SME. Organisations need the ability to manage projects on time, within budget and to specification in order to remain competitive and survive.

Project management is a well-established discipline defining in considerable detail the tools and techniques that are required to define, plan and implement any project. However, while many researchers have addressed the issues surrounding the management of projects within large firms (White and Fortune (2002); Bryde (2003)) there has not been a lot published to date about the management of projects in SMEs.

This paper examines previous empirical studies on Project Management implementation in various industry sectors and the criteria and factors most frequently adopted. The paper also examines the results of a survey distributed to over 100 Owner / Managers of High-Tech SMEs in Ireland that attempts to recognise the general characteristics of projects undertaken by SMEs, the issues they encounter and their opinions on how SMEs can achieve greater efficiency and competitiveness. The results will contribute to the development of a simplified process of Project Management suited to the needs of the SME.

1.0 Introduction

SMEs ranging from the dynamic, innovative and growth-oriented to the traditional enterprises satisfied to remain static are imperative to the economy as the engine of economic and social development Hallberg (1999). Floyd and McManus (2005) while examining the increasing significance of small firms in the EU, highlighted this fact by stating that increased importance has been given to SMEs with regards to industrial policy of the EU. According to the European Competitiveness report of 2003, SMEs account for 99 per cent of activity in the EU.

The potential threat to existence of SMEs leads to the conclusion that they need to increase their competitiveness and quality to match the competition. One innovative step that can enhance the chances of progression in SMEs is the introduction of the process of Project Management.

Project management is well established with White and Fortune (2002) describing it as a well developed and well accepted area of professional expertise and an area for academic research aimed at encouraging improvement in a system. Project Management offers a systematic approach to all stages of a project by ensuring that every step is carefully planned, monitored and accounted for.

Although initially intended for application in large organisations with complex systems that require such a process Baccarini (1999), modern methods of project management can be adapted and altered to suit the needs of the smaller organisations.
It is not only a process but a mindset also. Owners or senior management of SMEs must be open to its potential towards progression before it can be introduced as a beneficial process within the organisation.

This paper aims to provide the necessary information, gathered through a survey of over 100 SMEs, to develop a Project Management system based on existing tools and techniques to meet the needs of SMEs in producing and achieving credible project management plans.

2.0 SMEs: Characteristics and impact on the economy

The definition of SMEs has varied over time with some believing there has been a lack of homogeneity in their categorisation, (McAdam, Reid et al. 2005). For the purpose of this research, reference will be made to the definition set out following the European Commission recommendation on May 6th 2003 and that took effect on January 1st 2005. Table 1 below outlines the key aspects of the new definition as recommended by the European Commission.

Table 2.1: The new thresholds implemented by the European Commission on January 1st 2005

<table>
<thead>
<tr>
<th>Enterprise Category</th>
<th>Headcount: Staff</th>
<th>Annual Turnover</th>
<th>Annual Balance Sheet Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium – Sized</td>
<td>&lt; 250</td>
<td>≤ €50 million</td>
<td>≤ €43 million</td>
</tr>
<tr>
<td>Small</td>
<td>&lt; 50</td>
<td>≤ €10 million</td>
<td>≤ €10 million</td>
</tr>
<tr>
<td>Micro</td>
<td>&lt; 10</td>
<td>≤ €2 million</td>
<td>≤ €2 million</td>
</tr>
</tbody>
</table>

When researching the general characteristics of SMEs, comparative analysis with larger organisations helps to provide a clearer image of their standing in the market. SMEs exhibit both advantages and disadvantages when compared to larger organisations. Audretsch, Prince et al. (1998) in their comparative paper examining small and large firms identified key issues surrounding the SME. Small firms have a greater potential flexibility and closeness to the customer and an edge towards customisation and innovation. They seek out markets where their advantages count and they are not in direct competition with their larger counterparts.

However, they continue to state that despite these key advantages, SMEs lack economies of scale, scope and learning. Edwards, Delbridge et al. (2001), outline that SMEs exhibit behavioural features that give them an innovative advantage over large firms that include the ability to respond rapidly to external threats or opportunities, have more efficient internal communications and exhibit interactive management cycles. Rothwell (1992) makes reference to SMEs in their attempts to progress by stating that, ‘SMEs are thought to lack the material and technological resources that enable large firms to ‘spread risk over a portfolio of new products’ and ‘fund longer-term R&D’.

Table 2 highlights some of the key differences between SMEs and large organisations as suggested by (Ghobadian and Gallear 1997).
High Technology Small Firms Conference 2006

Table 2.2: Key differences between SMEs and Large organisations (adapted from Ghobadian & Gallear, 1997)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SMEs</th>
<th>Large organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td>Few or no layers of management</td>
<td>Several layers of management</td>
</tr>
<tr>
<td></td>
<td>Top Management close to the point of delivery</td>
<td>Top Management far from point of delivery</td>
</tr>
<tr>
<td></td>
<td>Low degree of specialisation</td>
<td>High degree of specialisation</td>
</tr>
<tr>
<td></td>
<td>High incidence of innovativeness</td>
<td>Low incidence of innovativeness</td>
</tr>
<tr>
<td><strong>Procedure</strong></td>
<td>Low degree of standardisation</td>
<td>High degree of standardisation</td>
</tr>
<tr>
<td></td>
<td>Low degree of formalisation</td>
<td>High degree of formalisation</td>
</tr>
<tr>
<td></td>
<td>People dominated</td>
<td>System dominated</td>
</tr>
<tr>
<td></td>
<td>Idealist decision making</td>
<td>Fact-based decision making</td>
</tr>
<tr>
<td><strong>Processes</strong></td>
<td>Simple Planning &amp; Control system</td>
<td>Complex planning &amp; control system</td>
</tr>
<tr>
<td></td>
<td>Informal evaluations &amp; reporting</td>
<td>Formal evaluation &amp; reporting</td>
</tr>
<tr>
<td></td>
<td>Result orientated</td>
<td>Control orientated</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>High degree of resistance to change</td>
<td>Low degree of resistance to change</td>
</tr>
<tr>
<td></td>
<td>Corporate mindset</td>
<td>Departmental mindset</td>
</tr>
<tr>
<td></td>
<td>Modest capital &amp; financial resources</td>
<td>Abundant capital &amp; financial resources</td>
</tr>
</tbody>
</table>

An examination of the skills of project managers in small and large electronics firms in Ireland (Ledwith 2004), showed that project managers in small firms were weak in the areas of motivation, marketing and management. Small Irish firms demonstrated limited use of project management techniques and were not benefiting from project management in terms of increased new product success. Despite this it was observed that by improving project planning, establishing clear priorities and setting clear objectives, small Irish firms could improve NPD performance by reducing project delivery times.

Statistics gathered by the Programme for Industrial Interface (PUII) in the University of Limerick shows that 95% of the trading entities and 80% of employment are made up by the SME. Günter Verheugen of the European Commission declared that: ‘Micro, small and medium-sized enterprises (SMEs) are the engine of the European economy. They are the essential source of jobs, create entrepreneurial spirit and innovation in the EU and are thus crucial for fostering competitiveness and employment.’ European Commission Publication (2005).

The economical importance of SMEs is also highlighted by (Floyd and McManus 2005) who identified examples of SMEs improving the competitive position of the EU:

- Small firms have fewer problems with labour relations than their larger counterparts.
- Small firms offer the benefit of being able to change production quickly.
- Small firms can offer personalised service, differentiating business activity.

Despite their strong potential as a driving force within Europe, SMEs are suffering from the effects of inflating running costs and external competition. Due to the lack of depth they possess in comparison to large organisations, the rising international economic threat posed by Asia and Eastern Europe can have overwhelming consequences for SMEs.
The Irish Small-to-Medium Enterprise Association (ISME) trends surveys reflect the economic effects on SMEs in Ireland over the last two years:

- **4th Quarter 2004**
  - Manufacturing sector reporting a significant recovery with one fifth of companies anticipating future job creation.
  - Business Optimism, employment creation and investment levels provide a positive platform for future development and growth in the SME sector.
  - Business costs continue to be a burden for SMEs
  - 19.3% of businesses report that sales/order books were below normal for the period.
  - Labour costs identified as the biggest threat to SME development and growth as confirmed by 23% of companies.

- **3rd Quarter 2005**
  - A report on areas of concern for SMEs shows the following breakdown:
    1. Labour Costs – 25%
    2. Erosion of competitiveness – 19%
    3. Economic uncertainty – 12%
    4. Reduced orders – 11%
  - A net decrease of 3% in exports represents a sharp reduction on previous quarters and indicates that the reduction in competitiveness is starting to impinge.
  - Reality on the ground shows that companies are finding it increasingly difficult to operate due to the high cost environment and external competition.

Issues seen in the trends surveys along with other issues mentioned sufficiently justify the need for SMEs to consider new methods to enhance their ability to compete and to grow.

### 3.0 Projects and Project Management:

#### 3.1 Projects

Any task undertaken that is specific, unique and with a specific aim to achieve it can be considered a project. PMI (2000) define projects as ‘a temporary (definitive beginning and definitive end) endeavour undertaken to create a unique (projects involve doing something that has not been done before) product or service.’ Kerzner (2001), through his book on Project Management outlined the key characteristics of projects:

- Projects are the change efforts of society and the survival of organisations in the modern environment is through effective management of change efforts.
- The Project is not synonymous with the product of the project. The project is the process by which the product is produced and has a finite life.
- Projects comprise of activities that are usually non-repetitive and inter-related.
- Projects involve multiple resources (human and non-human) that require close coordination.
Projects can be considered as the achievement of a specific objective and involve the utilisation of resources on a series of activities or tasks. (Munns and Bjeirmi 1996) in their paper on how to achieve project success, differentiate between project success and project management success. The definition of a project suggests an orientation towards higher and longer-term goals such as return on investment, profitability and competition, while project management focuses on short-term goals and a more specific context for success. Cooke-Davies (2002) proposes the distinction between project success and project management success:

- **Project Success** is measured against the overall objectives of the project,
- **Project Management Success** is measured against the widespread and traditional measures of time, cost and quality.

Munns and Bjeirmi (1996) conclude that despite the differences between project success and project management success they compliment each other. A project can succeed despite the failure of project management but successful project management implementation can increase the potential for success on an overall project scale.

### 3.2 Project Management: Definition and Principles

Project Management has existed, in theory, for centuries with its informal application by the Chinese and Egyptians with such feats as the Great Wall of China and the Pyramids. However, modern Project Management is a recent phenomenon gaining initial acceptance in the rapid development of the Information Technology industry, (Fox 2004).

Cicmil (1997), in a paper on critical factors of effective project management suggested the following:

‘In any project situation, there is a client/customer who has a unique need which requires knowledge and resources to conduct the realisation of the concept within the specific constraints of time, money and specification. The effective management processes of planning, monitoring and control are required to translate the idea of change into tangible deliverables.’

PMI (2000) supplied a simplified definition as ‘the application of knowledge, skills, tools and techniques to project requirements.’

The emergence of modern project management owes to three core stimuli, (Baccarini 1999):

1. **Complexity** – Growing complexity of tasks and a need for a greater degree of specialisation.
2. **Change** – Increasingly dynamic environments with constant pressure within organisations to implement change due to global competition.
3. **Time** – Demand for tasks to be completed as quickly as possible.

Project Management is an innovative process whose implementation is increasingly necessary in today’s competitive market. Undertaking any project now involves overcoming many obstacles (Kerzner 2001) that include project complexity, client special requirements, organisational restructuring and project risks. With a systematic process in place, such as Project Management, obstacles can be accounted for and actions or measures taken to either prevent or overcome them. Some of the many potential benefits project management provides as proposed by (Kerzner 2001) include:
• Identification of functional responsibilities ensuring that all activities are accounted for.
• Identification of time limits for scheduling
• Measurement of accomplishment against plans
• Early identification of problems
• Improved estimating capability

Essentially, project management is the planning, organising, directing and controlling of an organisation’s resources to achieve a relatively short-term objective. Over its course, modern Project Management as a discipline has emerged and has been constantly remoulding itself to allow for expansion in its practice. A valuable conclusion was made by (Crawford, Pollack et al. 2005) who carried out a study of the International Journal of Project Management and the Project Management Journal over the last ten years to try to uncover the trends in project management:
‘As a field, project management is regularly facing new challenges, as the tools, methods and approaches to management that comprise the discipline are applied to different areas, for different ends, in different cultures.’

3.3 Project Management: Success Criteria and Success Factors

A second distinction to be recognised when studying projects and their management is the distinction between critical success criteria and critical success factors. Cooke-Davies (2002) defined the difference as follows:

**Success Criteria** are the measures by which success or failure of a project will be judged. **Success Factors** are the inputs to the management system that lead directly or indirectly to the success of the project.

This distinction is supported by (Belassi and Tukel 1996) who recommend that sound research on critical success factors have to:
1. Distinguish between success factors and success criteria.
2. Distinguish success factors within the control of the project manager and factors outside his/her control.

Determination of a project’s success criteria has become far more complex in recent times (Belassi and Tukel 1996) with the three criteria of Time, Cost and Performance no longer sufficient. On any project, there are numerous parties involved with their own perception of success. These can include the Project Manager, Project Team, Top Management, the Client and external parties from the Political and Economical environments. A project perceived as a success by a project manager and his team, might be perceived as a failure by the client. In contrast, top management might deem a project to be a failure for not meeting specifications but may still satisfy the client. Pinto and Slevin (1989) recognised this ambiguity in determining project success by stating that it is still not clear how to measure success because the parties who are involved in projects perceive project success or failure differently.
From the perspective of developing a simplified method of project management for SMEs, it might be necessary to consider the perception of success from one party, namely senior management based on their overwhelming influence in SME procedures.

Research has contributed to a significant quantity of factors that could be described as critical to a projects outcome. But projects are individual and unique and lead to the understanding that success factors can differ between them. Belassi and Tukel (1996) proposed that, ‘a combination of many factors, at different stages of project life cycle, result in project success or failure’.

Table 3 outlines the key success criteria and success factors seen to be most significant from previous empirical studies.

Table 3.1: Critical Success Criteria and Success Factors

<table>
<thead>
<tr>
<th>Author</th>
<th>Success Criteria</th>
<th>Success Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>White &amp; Fortune (2002)</td>
<td>Complete within Schedule&lt;br&gt;Complete within Budget&lt;br&gt;Meet Client Requirements</td>
<td>Clear Goals / Objectives&lt;br&gt;Realistic Schedule&lt;br&gt;Top Management Support&lt;br&gt;Adequate Resources&lt;br&gt;Effective Risk Management&lt;br&gt;Clear Communication Channels</td>
</tr>
<tr>
<td>Belassi and Tukel (1996)</td>
<td>Cost&lt;br&gt;Time&lt;br&gt;Quality&lt;br&gt;Client Satisfaction</td>
<td>Clear Goals / Objectives&lt;br&gt;Top Management Support&lt;br&gt;Scheduling&lt;br&gt;Sufficient Resources&lt;br&gt;Planning &amp; Control&lt;br&gt;Monitoring &amp; Feedback&lt;br&gt;Client Consultation</td>
</tr>
<tr>
<td>Fortune &amp; White (2006)</td>
<td>Not addressed</td>
<td>Top Management Support&lt;br&gt;Clear and Realistic Objectives&lt;br&gt;Efficient Plan&lt;br&gt;Performance Monitoring&lt;br&gt;Communications&lt;br&gt;Resources</td>
</tr>
<tr>
<td>Westerveld (2003)</td>
<td>Budget, Schedule, Quality&lt;br&gt;Appreciation by Client&lt;br&gt;Appreciation by Project Personnel&lt;br&gt;Appreciation by users&lt;br&gt;Appreciation by contracting partners&lt;br&gt;Appreciation by stakeholders</td>
<td>Leadership and Team&lt;br&gt;Policy and Strategy&lt;br&gt;Resources&lt;br&gt;Stakeholder Management&lt;br&gt;Schedule&lt;br&gt;Risks</td>
</tr>
</tbody>
</table>
A trend emerges in Table 3, the three basic criteria of time, cost and quality appear regularly. Additionally, client satisfaction was deemed as significant and must be an objective to achieving overall project success. Westerveld (2003) factored in the appreciation of the various parties involved both directly and indirectly on the project but may lead to issues of conflict when determining whether a project was successful or not. The critical success factors uncovered many varying factors that could be implemented and used as a tool for success. Before considering these factors, it is important to reiterate that SMEs are generally characterised as having basic organisational structures with simple planning and control systems in place. Therefore, a new process of project management for SMEs would be more beneficial as a simplified methodology with specific reference to selected focus on key factors. Having reviewed the factors considered above, six were highlighted as having the greatest potential influence:

- Top Management Support
- Clear Goals / Objectives
- Planning, Monitoring & Control
- Resource Allocation
- Risk Management
- Client Consultation

The factors above are considered to be ‘critical’ to successful implementation of project management on projects and can be with the correct approach, can form part of a process suited to SMEs. All six factors form a question in the empirical study to seek the opinions of SME owner – managers as to their significance or importance in undertaking a successful project.

4.0 Empirical Study Methodology

4.1 Questionnaire Design

A questionnaire was developed as the first stage towards the development of a new project management framework for SMEs in Ireland. The main objectives in developing the questionnaire were to explore the following:

1. Current structures in place such as organisational structure and decision-making authority.
2. The level of importance placed on projects, the basic characteristics of projects (level of investment, duration and staff delegation) and perceived success of projects to date.
3. The level of recognition of Project Management as a process in SMEs that includes implementation and associated techniques, and general opinions of its potential as a process.
4. Criteria used to base success upon and factors implemented to achieve success on projects.
5. Opinions towards future methods of project improvement in SMEs and reasons behind lack of research in the area.

With the focus being placed primarily on High-Tech SMEs, organisations in the industry sectors of Medical Devices, Electronics and Telecommunications were sought. High-
Tech SMEs were considered more relevant to the survey as they are more likely to contain relatively complex production systems and would find the process of project management beneficial and in some cases, necessary. The Kompass website, providing general information on organisations across Ireland was used as the source for the collection of organisations to be included in the distribution list. Selection of SMEs from the database was dependent on two factors: Number of Employees and Industry Sector. With reference to Table 1, any organisation with an employment level of less than 250 people was considered for inclusion. The questionnaire was piloted with two SME owner-managers. These pilot tests lead to improvements in wording, and the removal and addition of some questions. The questionnaire was distributed to over 100 organisations via email. The questionnaire was sent to the attention of owner-managers because their opinions would be most influential in SMEs. By directing it to owner-managers, it could confirm or not, the opinions that they tend to be traditional in their ways and lack openness to new and innovative processes.

5.0 Results & Discussion
The research is at an early stage; only 12 responses have been retrieved to date. This section highlights the critical results found and discusses their significance.

SME Characteristics
Tables 4.1 and 4.2 present the key results of the research. Results show that the majority of SMEs operate under a matrix structure signifying recognition of the need to have a strong structure in place. This is supported by the strong agreement to the statement that organisational structure affects the management of projects. As expected, owner-managers are most influential in the decision-making processes followed by functional managers and projects steering groups. These trends suggest the existence of traditional methods of management. Added to that, only 50% of the respondents claimed that there is a full-time project manager in their organisation. These findings put weight to the belief that owner-managers are close to all aspects of company actions and back the literature findings (Ghobadian and Gallear 1997) that little or no layers of management are in place.

Project Characteristics
The results highlight that projects undertaken by SMEs are generally small in nature with the majority of the respondent organisations spending between 0-20 percent, as a percentage of turn-over, on projects, have only 1-10 staff working on projects and project durations varying between 0-12 months but no more. However, there was majority agreement on the statement that projects undertaken are complex in nature. Regarding the Project Life Cycle phases, most organisations are involved in all stages with the phases of Conceptual, Planning and Implementation considered most important in that order. The significance of the Conceptual phase is highlighted by the respondent organisations belief that sufficient research and analysis is carried out before undertaking a new project.
### Table 5.1 Breakdown of findings from Project-based questions

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Sector</th>
<th>No. of Staff</th>
<th>Organisation Structure</th>
<th>Project Manager</th>
<th>Project Life Cycle Phases</th>
<th>Project Expenditure (as % of Turnover)</th>
<th>Project Staffing</th>
<th>Project Durations</th>
<th>Project Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medical Devices</td>
<td>32</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>0-20%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>3.66</td>
</tr>
<tr>
<td>2</td>
<td>Medical Devices</td>
<td>50</td>
<td>Matrix-Functional</td>
<td>Yes</td>
<td>Yes</td>
<td>0-20%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4.00</td>
</tr>
<tr>
<td>3</td>
<td>Medical Devices</td>
<td>110</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>20-40%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4.33</td>
</tr>
<tr>
<td>4</td>
<td>Electronics</td>
<td>130</td>
<td>Matrix-Functional</td>
<td>Yes</td>
<td>Yes</td>
<td>20-40%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>2.00</td>
</tr>
<tr>
<td>5</td>
<td>Manufacturing</td>
<td>34</td>
<td>Matrix</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>3.33</td>
</tr>
<tr>
<td>6</td>
<td>Telecommunications</td>
<td>32</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>60-80%</td>
<td>10-30</td>
<td>3-6 months</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Engineering</td>
<td>60</td>
<td>Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Manufacturing</td>
<td>30</td>
<td>Matrix-Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>6-12 months</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Telecommunications</td>
<td>130</td>
<td>Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3.33</td>
</tr>
<tr>
<td>10</td>
<td>Manufacturing</td>
<td>85</td>
<td>Functional</td>
<td>Yes</td>
<td>Yes</td>
<td>0-20%</td>
<td>1-10</td>
<td>3-6 months</td>
<td>3.33</td>
</tr>
<tr>
<td>11</td>
<td>Electronics</td>
<td>42</td>
<td>Matrix-Functional</td>
<td>No</td>
<td>No</td>
<td>0-20%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3.33</td>
</tr>
<tr>
<td>12</td>
<td>Manufacturing</td>
<td>50</td>
<td>Matrix</td>
<td>Yes</td>
<td>Yes</td>
<td>20-40%</td>
<td>1-10</td>
<td>&gt;3 months</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Note: The scores displayed under ‘Project Success’ are the average of ratings for project success under the headings of Budget, Schedule and Performance.

### Table 5.2 Tabulated Result Sets

<table>
<thead>
<tr>
<th>Influential Decision Makers</th>
<th>Level of Importance of Project Life Cycle Phases</th>
<th>Most significant success criteria</th>
<th>Most Influential Success Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td>PHASES</td>
<td>Res Av.</td>
<td>CRITERIA</td>
</tr>
<tr>
<td>Project Manager</td>
<td>Conceptual</td>
<td>3.80</td>
<td>Completed within Budget</td>
</tr>
<tr>
<td>Owner - Manager</td>
<td>Planning</td>
<td>3.70</td>
<td>Completed within Schedule</td>
</tr>
<tr>
<td>Project Steering Group</td>
<td>Testing</td>
<td>3.20</td>
<td>Meets required quality standard</td>
</tr>
<tr>
<td>Board of Directors</td>
<td>Implementation</td>
<td>3.80</td>
<td>Meets specification</td>
</tr>
<tr>
<td>Functional Managers</td>
<td>Closure</td>
<td>3.00</td>
<td>Appreciation by users</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>2.67</td>
<td>Appreciation by stakeholders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Appreciation by project personnel</td>
</tr>
</tbody>
</table>

Note: Res. Av = The average response to the factors seen above.
### Table 5.3 Levels of agreement to statements

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>Response Average</th>
<th>STATEMENTS</th>
<th>Response Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational Structure affects the management of projects</td>
<td>4.00</td>
<td>Project Management can be applied in similar fashion in SMEs as in large organisations</td>
<td>3.63</td>
</tr>
<tr>
<td>A change of organisational structure would have a positive impact on project execution in my organisation</td>
<td>3.38</td>
<td>Previous experience is a key factor to implementing an effective system of project management</td>
<td>4.13</td>
</tr>
<tr>
<td>Projects undertaken by my organisation are generally complex in nature</td>
<td>3.38</td>
<td>Sufficient research and analysis is carried out before undertaking a new project within my organisation</td>
<td>3.38</td>
</tr>
<tr>
<td>Projects undertaken by my organisation involve close collaboration with client organisations</td>
<td>3.63</td>
<td>A project can be successful despite the failure of project management</td>
<td>2.38</td>
</tr>
<tr>
<td>Projects undertaken by my organisation involve close collaboration with the suppliers</td>
<td>3.75</td>
<td>Success of projects within my organisation is mainly dependent on external factors (e.g. market demand, government regulations)</td>
<td>3.25</td>
</tr>
<tr>
<td>Large organisations approach projects in a different manner to SMEs</td>
<td>4.00</td>
<td>Success of projects within my organisation is mainly dependent on internal factors (e.g. project management, proficiency)</td>
<td>3.38</td>
</tr>
<tr>
<td>Large organisations possess advantages over SMEs in project implementation</td>
<td>3.50</td>
<td>A well defined project management process is a necessity for successful implementation of projects</td>
<td>4.25</td>
</tr>
<tr>
<td>Adequate research and facilities on best practice in the field of project management are available to SMEs</td>
<td>3.00</td>
<td>Success criteria measures used by my organisation are sufficient to determine project success</td>
<td>3.63</td>
</tr>
</tbody>
</table>

Note: A 1-5 scale was used for the statements where: 1= Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

### Table 5.4 Open question responses

**How can project performance be improved?**
- Prioritisation of project tasks over other work
- Reviewing EVMS methods and honing CPI and SPI introduction of a strong matrix management structure
- By people being trained to understand the principles and benefits of same
  1. Training of Project Managers. 2. Clearer Goals being set and communicated to all staff involved. 3. Better client or fact finding on site at conception stage
- More control of project team

**The conception among SMEs that Project Management is too complex a process / technique to implement and is more suited to larger organisations**
- No, it can actually be easier to implement in a smaller organisation.
- No. I have worked in industries of various sizes – the approach is different but the tools are the same
- You would want to be clearly identify the benefits of it and then it may not be that complex to achieving the implementation of same.
- No, I do not agree, it is as easy to implement. It is just that in SMEs it is very difficult to afford the time and the resources…..it is a growing issue for a company and a mindset.
- No, if adequate time and resources are given then there should not be any problems

Success of projects is based more on internal factors than external based on trends in statement results. ‘Clear Goals/Objectives’ and ‘Senior Management Support’ were both considered most important as factors towards success and again supports the literature. Other factors, in order of importance included, ‘Resource Allocation’, ‘Planning Monitoring and Controlling’ and ‘Client Consultation’. These results would not be considered as unusual. Resources are always an issue for SMEs and must be managed effectively, planning and controlling of projects is vital, particularly on complex projects and client consultation is critical in both the implementation and planning phases of a projects life cycle.
When compared to large organisations, SMEs agreed that there is a different approach made to projects and that large organisations possess advantages over SMEs in project implementation. These results are expected with large organisations possessing greater capital and resources and a greater degree of specialisation than their SME counterparts, (Ghobadian and Gallear 1997). When asked how they could improve project performance, respondents suggested prioritisation of project tasks over other work, more control of project team, clearer goals and communication channels and better client or fact-finding at conception stage.

**Project Management**

One interesting finding was the disagreement to the statement that projects can be successful despite the failure of project management. This signifies a belief in project management as a process of improvement and is backed by the agreement to a well-defined project management process being a necessity for successful implementation of projects. Of the respondents, 60% consider project management an identifiable process in their organisation, a substantial quantity considering the lack of research and facilities available to SMEs on project management. A variety of tools and techniques are being used (see figure 4.4) with Project Planning, Project Teams and Gantt Charts featuring most regularly. However, these tools would be considered as fundamental tools to implement and possibly show that although a system of project management is in place, it may only provide basic planning abilities.

**Figure 5.1 Project Management Tools & Techniques implemented**

Despite considering that SMEs approach projects differently to large organisations, a significant proportion of respondents believed that project management could be implemented in similar fashion to large organisations. The open-ended question on the subject of project management being too complex a process to implement in SMEs showed sufficient disagreement to summarise that with the right approach and allowable time, project management could be incorporated with maximum effect.
6.0 Conclusion

The findings of the questionnaire are an initial attempt to understand the current practices in SMEs in Ireland and the opinions of SMEs to the potential of project management as a process of improvement. From initial findings it is clear that despite the lack of research and facilities available to them, SMEs are clearly aware of project management and the benefits it offers but obstacles of time, money and resources can prevent its implementation. With respect to the development of a methodology suited to the needs of SMEs, experiences of respondents have shown that understanding the tools and techniques being used by larger organisations and tailoring them to suit the SME environment is the best approach to take.

Further investigation will include case studies in selected organisations to expand the existing information on SME practices required for a new framework of Project Management to be developed.

7.0 References


THE MARKETING SCIENCE INTERFACE: PROMOTING THE ENTREPRENEURSHIP AGENDA WITHIN THE SCIENCE, ENGINEERING AND TECHNOLOGY (SET) CONSTITUENCY OF HIGHER EDUCATION.

Dr Pauric McGowan, Director of the Northern Ireland Centre for Entrepreneurship (NICENT), University of Ulster, Jordanstown Campus, Newtownabbey, County Antrim, BT37 0QB, N Ireland.
Tel: 44 (0) 28 9036 8864 Email: p.mcgowan@ulster.ac.uk
Website: http://www.nicent.ulster.ac.uk

Sharon Porter, Teaching Fellow in Entrepreneurship, Northern Ireland Centre for Entrepreneurship (NICENT), University of Ulster.

Micheal Brennan, School of Marketing, Entrepreneurship and Strategy, University of Ulster.

Keywords: Culture; Entrepreneurship; Education; Marketing; Policy; Selling.
1. Introduction

University based entrepreneurship in the UK is of increasing interest to both policy makers and university managers; evidenced by government sponsored initiatives such as the Science Enterprise Challenge, (SEC) in the UK – promoting entrepreneurship within higher education and the more recent development of the National Council for Graduate Entrepreneurship, (NCGE). However, while the idea of the “entrepreneurial University” has begun to find support within a small number of constituencies the literature suggests that there are still a considerable number of barriers to the promotion of entrepreneurship within universities, in the UK, as well as across the EU and indeed the US, (Morrison 2004, Bok 2003, Etzkowitz 2003, Clarke 1998, 2003). While there is a growing agreement about the need for UK universities to become more entrepreneurial, a crucial question it seems is how might this be done effectively? (Gibb 2000).

In this paper, using a case study approach, the authors seek to provide an answer to this question. They explore the challenges that exist in seeking to migrate the agenda for entrepreneurship out of the faculties of Business and Management where it is traditionally lodged within most universities and into the faculties of Science, Engineering and Technology, (SET), where, for all sorts of reasons, it is viewed as foreign and a threat. They present insights to the some of the challenges faced in engaging academic entrepreneurs and nascent entrepreneurs within the university partnership which involved the University of Ulster and Queens University, Belfast, represented by the Northern Ireland Centre for Entrepreneurship, (NICENT).

The outcomes of the paper are presented as a contribution to those seeking to better understand entrepreneurship in different university settings. The authors fully recognise the limitations of such a case approach as a basis for generalisations. Nevertheless, given the paucity of extant research in the area and the unique role that individual universities play in regional economies, such an approach was felt to have merit and to be of interest to those involved in seeking to find innovative ways to push the agenda for entrepreneurship within the higher education sector, (Tidd et al 2001, Shane 2004).

1.1 Overview

In recent years the UK government has determined that the higher education sector must play a much greater role in generating a stronger environment for entrepreneurial activity. The output of any of the UK’s universities in terms of qualified graduates and primary research can clearly be a major influence in determining the economic potential of the region in which it is located and beyond. The ambition of many universities to respond to these challenges presented by government and, sadly, to a lesser extent industry, to increase for example the incidences of effective commercialisation of ongoing research must be seen to be a function of how well they position themselves as entrepreneurial institutions. A key determinant of success in this strategy is the development of a culture of entrepreneurship amongst both the student body as well as amongst academic staff.

A starting point for creating such a culture is the development and the implementation of an appropriate curriculum for entrepreneurship particularly with in the faculties of Science, Engineering and Technology, (SET). It is in these faculties that the potential for new ideas for new products and processes must be seen to be high but where such a curriculum has rarely if ever existed. Selling the idea that entrepreneurship is important to Scientists, Engineers and Technologists within universities however is no easy enterprise and seeking to persuade them
that it should form a part of the curriculum for their students at every level within the SET faculties means resorting to every trick in the sales manual if buy-in is to be achieved and ownership taken up. Before considering a classical sales model as a basis for promoting the entrepreneurship agenda within the SET faculties within the NICENT partnership, let us consider first what an “entrepreneurial university” is and some of the difficulties that exist for universities aspiring to become one.

1.2 Characterising the Entrepreneurial University

The entrepreneurial university is one that facilitates the creation of value for society and economic wealth through new and innovative undertakings. The term reflects a philosophical ‘maturation’ of the concept of entrepreneurship to include socio-economic value in addition to an association with job creation and new firm creation (Kao, 2002). This socio-economic mission is an expansion of the teaching and research missions that traditionally determined the priorities and direction of universities (Etzkowitz, 2003a). At the heart of the entrepreneurial university is innovation – what Drucker called “the effort to create purposeful, focused change in an enterprise’s economic or social potential” (Drucker, 1985, p. 67). The purpose of the entrepreneurial university, some argue, is to transform academic knowledge into economic and social utility (Bok 2003, Clarke, 1998)

On the basis of a review of five leading European universities perceived as entrepreneurial, Clarke further identified pathways important for organisational transformation to be considered an entrepreneurial university:

- A strong steering core for monitoring and reacting to environmental change
- Boundary spanning structures and mechanisms
- A diversified funding base
- A strong academic heartland accepting of an entrepreneurial culture
- An integrated institutional entrepreneurial culture

In addition Etzkowitz (2003b) identified at least five key elements of an entrepreneurial university:

- The organisation of group research
- The creation of a research base with commercial potential
- The development of organisational mechanisms to move research out of the university as protected intellectual property
- The capacity to organise firms within the university
- The integration of academic and business elements into new formats such as university-industry research centres

Clark’s transformational pathways and Etzkowitz’s organisational elements are a reaction to, and to a degree influence, the changing policy perspectives of how universities are perceived and understood in knowledge-based economies. Evidence of new attitudes as to the changing role of universities reflected in recent policy reviews are reflected in the following examples: “Universities will have to get better at identifying their areas of competitive strength in research. Government will have to learn to do more to support “business – university” collaboration. Business will have to learn how to exploit the innovative ideas that are being developed in the university sector”. (Lambert Review of Business-University Collaboration, 2003, p. 2)
“In a knowledge based economy both our economic competitiveness and improvements in our quality of life depend on the effectiveness of knowledge sharing between business and higher education”. (The Future of Higher Education 2003, p.36)

Such policy perspectives have invariably been translated in the UK into funding streams to support various initiatives at different levels. Examples of these are:

- University structures and systems - the Higher Education Reach out to Business and the Community initiative
- Discipline areas - the Science Enterprise Challenge in which NICENT is a partner
- Funding academic spin out firms - the University Challenge Fund
- Supporting knowledge transfer - the Teaching Company Schemes/Knowledge Transfer Schemes.

At the core of any ambition to create the entrepreneurial university, however is a clear need to generate an appropriate culture that encourages staff and students to be continuously innovative and opportunity focused and that allows them to be comfortable with the changes that will be the inevitable outcome of such innovative and opportunity focused activities. Generating such a culture requires the support of those at the highest level in the institution as well as buy-in from everyone else. Those who challenge the status quo, who break the mould, if they are not driven out of the university by reactionary forces and defenders of that status quo, will become the new heroes and should be feted as such. Their stories should become the stuff of legend for others to emulate. Such is the raw material of an entrepreneurial culture. Experience, however, tells us that challenging the status quo is easier said than done and can actually be down right dangerous to career prospects.

This is said conscious, of course, of the questioning by many about the appropriateness of promoting this agenda within academia at all. Bok 2003, for example, writes in the preface to his book about universities in the market place:

“...I wonder that commercialisation may be changing the nature of academic institutions in ways that we will come to regret. By trying so hard to acquire more money for their work, universities may compromise values that are essential to the continues confidence and loyalty of faculty, students, alumni, and even the general public”

2. Marketing the Entrepreneurship Agenda within the SET Constituency

Key challenges and potential barriers to effectively promote and build an infectious culture for entrepreneurship within traditionally grounded higher education institutions can be considered under four headings. Firstly, credibility, which focuses on issues of quality, relevance and the value, attached to the entrepreneurship agenda by the target faculties. The second is transferability, and addresses the issue of what entrepreneurship means in the minds of those within the target market and the different constituencies within that market. Confirmability is the third issue and deals with the need to establish the efficacy of the efforts being made to push the agenda for entrepreneurship across the different constituencies within the SET faculties and finally there is dependability which addresses the important challenge of sustaining the agenda, supporting it in its infancy and protecting it against the many counter revolutionaries and vested interests that will undoubtedly seek to reverse any progress made in pushing the agenda within the SET faculties.
2.1 Selling the message, “Entrepreneurship is good for you, Mr/Ms Engineer, Scientist, Technologist”- the NICENT experience

In the late 1990’s a specific strategy was adopted by the UK government, keen to do something to generate a greater entrepreneurial culture within the SET faculties in universities across the UK. The Science Enterprise Challenge (SEC) network that emerged saw the establishment of 13 centres of excellence in entrepreneurship education within clusters of different UK universities. NICENT was one such centre. It was established in 2000 and funded by the Office of Science and Technology and Invest NI. It is a partnership between the University of Ulster and Queens University Belfast. Both universities have between them some 50,000 students pursuing programmes at undergraduate, postgraduate taught and postgraduate research, in Science; Engineering; Technology; Social Science; Humanities; the Arts, and Business and Management.

NICENT was charged with seeking to embed entrepreneurship within the curriculum at all levels within the SET faculties. Furthermore, the Centre sought to engage the teaching and research staff within this constituency with the entrepreneurship agenda. Indeed, it was crucial to recognise the pivotal role that teaching colleagues played in determining the likely success or failure of this endeavour over the longer term. Issues of understanding how entrepreneurship could be interpreted and of establishing relevant value and appreciation for the future development of students (and subject areas) within these faculties was crucial. Furthermore, a means to meet the learning needs of students exposed to entrepreneurship for the first time in these faculties had to be developed that had credibility in the eyes of academics, governing bodies and associated interest groups were relevant. In the best practice of sales, initial selling resistance had to be overcome, buying signals identified and every effort made to close the sale.

As consequence of NICENT’s efforts to date to market the entrepreneurship agenda within the SET faculties, primarily through the adoption of a curriculum development strategy, for the academic year 2004/05 over 6,948 students within the SET faculties were exposed to entrepreneurship learning for the first time across the Partnership.

To sell the message that entrepreneurship is good for staff and students within the SET faculties, however, means addressing those challenging issues highlighted above, dealing with objections and closing the sale by essentially getting buy-in. Developing an appropriate sales message starts with a consideration of what is for sale, to whom, at what “price”, how and at what cost?

In marketing terms “a product” is any good, service or idea that someone wishes to sell to another. In this case the product for sale, in its simplest terms it is that “entrepreneurship is good for both teaching and research staff and students within the faculties of Science, Engineering and Technology, (SET) within the higher education sector. Experience has shown that it is a message that has to be “sold” largely in the face of considerable scepticism and often, outright opposition. Of course, nothing in life is ever simple and selling such an intangible concept as entrepreneurship is probably as complex a challenge as anyone is likely to face in a university context.

The first major challenge arose because staff members, at different levels, as well as in the target faculties, were confused about what was meant by the term “entrepreneurship”. Many within the latter constituency were particularly sceptical of its relevance to them and their
students. The most common misunderstanding was that entrepreneurship is only about starting a business. Therefore, many schools, particularly within Life and Health Sciences, did not consider entrepreneurship relevant to their programmes of study. To view entrepreneurship as being only about new venture starts was too myopic for NICENT and was at odds with extant research. It would also lead to entrepreneurship having nothing to say to the majority of staff members and students within the wider SET constituency.

Initial discussions with the SET faculties were very beneficial as they allowed us to identify the needs and concerns of our target market and how best to position our agenda within the individual faculties and schools. NICENT quickly realised that we had to put customer benefits to the fore and, in turn, these benefits would help to create desire for the entrepreneurship agenda.

Thus, in order to effectively deal with the issues of credibility and transferability, NICENT emphasised a broad interpretation of entrepreneurship that includes not only new business creation but also the dimensions of social entrepreneurship, academic entrepreneurship and intrapreneurship. To reflect this wider interpretation, entrepreneurship was defined as “initiating change for social good”. Terms such as “new venturing” and “the new venturer” were used to help broaden understanding coupled with the promotion of a skills for life focus.

Every opportunity was taken by NICENT to spread this understanding of entrepreneurship. An effective public relation strategy was considered a key aid in gaining the support of faculties. If staff could see the relevance and value of entrepreneurship within the curriculum then they would be more likely to support its adoption and not consider it as being the latest “buzz” term, particularly, if the NICENT message could be communicated in an effective manner.

There was a potentially wide and varied market for the entrepreneurship message. This market included senior management within the University itself, through to senior staff within the target faculties, through to staff members who had always hankered after the opportunity to do something innovative and to behave entrepreneurially in a proactive manner, through to those who were more reactive and so on to those who were totally resistant to the whole idea. Beyond them then were the different student groups, those on undergraduate courses, or postgraduate taught programmes through to those on postgraduate research programmes.

To get buy-in to the idea that staff and students within the SET faculties need to know about and learn to apply entrepreneurship meant resorting to tried and tested sales techniques and strategies. The challenge to those of us in NICENT seeking to make the sale was to promote the benefits accruing from adopting the agenda, overcoming objections and close the sale. The AIDA Model helps to encapsulate NICENT’s “sales” strategy, developed to effectively address a challenging and complex sales environment.

2.2 Following a Classic Sales Model
The AIDA Model, developed by St. Elmo Lewis (circa 1898), attempts to explain how personal selling works. AIDA is an acronym that describes a common list of events that is very often undergone when a person is selling a product:

1. **A** - Attention - to attract the attention of the customer and create awareness of the product.

2. **I** - Interest - to get the customer interested by demonstrating its features, advantages,
and benefits of the product.

3. **D** - Desire - to convince the customer of the product's benefits and its ability to satisfy specific needs.

4. **A** - Action - to push customers toward actually purchasing the product.

In the process of selling the entrepreneurship agenda, the steps highlighted above were systemically “climbed” by the NICENT team. The Model intuitively makes sense. Following its steps has enabled the NICENT message to be successfully developed and sold to the target market. In addition, post-purchase satisfaction was also important to help achieve sustainability and positive word of mouth within the target market. This was achieved through goods salesmanship and reassurance via the provision of a quality after-care service.

3. **The NICENT Partnership Approach**

With differing educational perspectives and individual cultures, each Partner faced it’s own unique challenges in embedding the entrepreneurship agenda within their institutions. It became apparent that in order for NICENT to successfully fulfil it’s mandate a “one size fits all” strategy would not work across the Partnership and a less generic approach was required.

In the initial stages the largest group within the faculties, the undergraduate constituency was targeted. The first challenge was that within both universities the numbers to be introduced to the agenda were substantial. Strategies to market the agenda differed between the institutions as each Partner was allowed flexibility within the overall NICENT strategy to develop specific responses to meet the individual challenges each faced.

NICENT has successfully developed joint initiatives to support the agenda such as establishing entrepreneurship awareness learning outcomes; an assessed Certificate in Entrepreneurship Studies; the 25K Competition managed by Investment Belfast; joint training and development activities; the establishment of the Northern Ireland Entrepreneurship Network and individual entrepreneurship clubs.

The key challenges that each Partner has faced, and the key enablers each has used to embed within their institutions will now be explored.

3.1 **NICENT at the University of Ulster**

At the University of Ulster (UU) a very specific policy was adopted which recognised a number of important issues within the target faculties. Firstly, there were too few within the target faculties concerned who understood the subject let alone could teach the material with any credibility. The few that did exist were already too busy as practicing Academic Entrepreneurs. Secondly, the Centre was committed to promoting the agenda to a very large number of students in a range of disparate courses across the faculties concerned. As a consequence, NICENT UU took two key steps.

The first step was to develop a new module in “Entrepreneurship Awareness” to be presented wholly on-line using e-Learning. The pedagogic basis for this approach emphasises the importance of student centred, independent learning as being key to encouraging entrepreneurial learning. The challenge then was for the NICENT team to negotiate with course planning teams within the University to accommodate the module within courses. The hard sell began.
The second step was to work closely with course planning teams to ensure that the learning outcomes for entrepreneurship were embedded in the course where the bespoke e-Learning module could simply not be accommodated. In this way, NICENT working with course planning teams, sought to negotiate where and how the learning outcomes could be introduced and assessed in different modules making up the programme over the duration of the student life cycle. This required a review of each of the modules within the course, seeking edits and revisions were required to accommodate the learning outcomes for entrepreneurship. This was called the “spread option”. In order to be able to see where learning outcomes were lodged and assessed within a course, NICENT UU developed a tracking mechanism. The learning outcomes were introduced to courses progressively over the five years of the project through engagement in the rolling programme of course reviews and revalidations exercises that required course planning teams to submit their programmes to a critical external examination on a five year cycle. One prominent example of NICENT UU’s success has been the introduction of entrepreneurship learning outcomes to all pre and post registration courses in the School of Nursing within in the Faculty of Life and Health Sciences.

A third step to building on the entrepreneurship awareness agenda was to provide students with an opportunity to apply their knowledge in practice. To this end NICENT co-sponsored a local enterprise competition, the 25K Competition, targeting the higher education sector. The competition, now in its sixth year, has lead to the establishment of 12 spinout companies.

A further step was to organise personal development training for staff drawn from the SET faculties to teach entrepreneurship and to manage the e-Learning modules. These ranged from in-house programmes to engagement in an Entrepreneurship Development Programmes run by the SEC network in the UK along the lines of the MIT EDP, to supporting faculty to attend the EDP at MIT and the Price Babson Programme at Babson College. The rationale behind encouraging academic colleagues from within the SET faculties to become involved was to encourage buy-in, build knowledge in a way that was credible and would build confidence. All the time the hope was that ownership for the agenda would begin to become embedded in the SET faculties. There were those too, from within the SET faculties, who expressed a real interest in receiving enterprise development training for start-up activity or for the development of an existing enterprise. Here too, NICENT sought to play a role by organising business planning programmes and ideation workshops.

Key to the success of NICENT UU was the support of management at the most senior level of the partner institutions. This emphasised the importance of the agenda at the highest level and sent a clear message to course planning teams of the importance of adhering to the University’s demands for greater entrepreneurship within course documentation. The rolling programme of course review and revalidation also provided NICENT with a unique opportunity to intervene and negotiate for the introduction of the learning outcomes to courses. In addition, a new policy on staff promotions was introduced that reflected the commitment by senior staff in the UU to encouraging academic members of staff to engage with the entrepreneurship agenda. As a consequence, faculty members who engaged in promoting the entrepreneurship agenda within his or her faculty, either through teaching, research or new venturing activity became eligible for promotion. Performance in the arena of Academic Enterprise became a third avenue for faculty staff seeking promotion in addition to quality in teaching and research activity.
3.2 NICENT at Queen’s University Belfast

Queen’s places considerable emphasis on building its reputation as a centre of academic excellence and research. The ongoing challenge for the university therefore has been how to implement entrepreneurship into the agenda without compromising academic rigor and teaching quality as assessed by subject review. It was apparent that unless entrepreneurship became part of the compulsory module content much impact would be lost. In order to address this challenge Queen’s made a number of significant decisions. Firstly, a NICENT planning committee was formed comprising ‘Enterprise Champions’ from the engineering and science faculties and other individuals who had considerable expertise in this field. The Pro-Vice Chancellor chaired this committee for Teaching and Learning, thus establishing the importance of the agenda that the university attached to it. Secondly, and as a consequence entrepreneurship was added to the official teaching and learning strategy of the university. Thirdly, a cohort of Teaching Fellows in Entrepreneurship, based within the School of Management and Economics, was created to focus on undergraduate entrepreneurship curriculum development and teaching delivery.

In order to promote entrepreneurship, NICENT staff at Queen’s decided to adopt the ‘learning by doing’ approach, incorporating the use of small groups, role-plays, case-studies and business simulations. This approach was deemed the most appropriate in order for students to engage with the entrepreneurship agenda, whilst at the same time complementing the traditions at Queen’s. One of the main challenges was that certain degree courses offered at Queen’s such as engineering, medicine and law have professional accreditation and the professional bodies have a major influence on curriculum content. Moreover, the implementation of entrepreneurship into an already packed curriculum posed specific challenges for academic staff already challenged by research obligations, and providing quality assurance on teaching and learning. Consequently, embedding enterprise into the curriculum was not seen as a key priority particularly in areas where there were no obvious links to enterprise and innovation. However, as Queen’s had made a contractual obligation to embed entrepreneurship in the science and engineering curriculum it was felt important to gain individual schools’ commitment through the provision of customized solutions for each degree pathway. Consequently, NICENT staff designed both a stand-alone entrepreneurship awareness module and a blended module whereby entrepreneurship awareness was delivered within a complementary existing module. The modules were also designed to introduce students to the possibility of self-employment as a possible future career alternative. Consequently this frontline strategy using ‘people on the ground’ stands in sharp contrast to its partner, University of Ulster, which utilises eLearning in its delivery of entrepreneurship education.

NICENT at Queen’s has had to build an awareness of entrepreneurship and encourage a more receptive culture in the science and engineering faculties. This was not easy as enterprise was initially viewed as counter to the academic culture. In fact, gaining the balance between education and training was a particular challenge as it was paramount that the Queen’s reputation for teaching quality and research was not in any way diluted.

4. Concluding Comments

In the Northern Ireland context, a higher fear of failure exists amongst potential entrepreneurs of both sexes (43% in Northern Ireland compared with 32.9% in the UK) (O’Reilly and Hart, 2004). However, the NICENT Partnership has had a major role in shaping attitudes, values
and beliefs of individuals towards risk-taking behaviour. This change has been significant, not just within the student population, but also amongst the academic staff.

For the academic year 2004/05, NICENT once again exceeded performance targets for students exposed to entrepreneurship awareness education (6948 students). By the end of the academic year 2005/6, it is estimated that over 15,000 students will have undertaken entrepreneurship education and training as part of their undergraduate to post-doctoral studies since the Partnership was established in 2000.

Initial feedback from independent reviewers (BDO Stoy Hayward) suggests that NICENT is having a positive impact and had the Centre not been created no progress in this agenda would have been made. However, in some respects the agenda could be considered rather sterile. Building awareness has its limitations (Hytti and Kuopisjarvi 2004). If there is to be real attitudinal change, application is a much better strategy.

Much remains to be done to meaningfully meet the challenges highlighted by GEM research and Invest NI. The Region has been devastated by a decline in traditional industries such as shipbuilding, textile and aircraft manufacture. It is overly dependant on the public sector. It is estimated that over the next five years some 75,000 jobs will have to be lost within the public sector, at least, in order to bring it more in line with the norm for other regions of the UK. Building a new culture for enterprise, one that is truly entrepreneurial, is a challenge that will take time.

Machiavelli is credited with the statement that “…there is nothing more difficult to carry out nor more doubtful of success nor more dangerous to handle than to initiate a new order of things.”

Culture change takes time, patience, risk-taking and lots of sweat equity and not a little vision. It requires an entrepreneurial response. The challenge for NICENT is to extend its efforts beyond the SET constituency to all faculties within our institutions, to build international networks in entrepreneurship education and exploitation, as well as share experience and best practice.

The overall NICENT strategy involves a pull-push marketing policy to stimulate the entrepreneurial potential within the Partnership’s institutions. Our role has been to develop this talent to the extent were the enterprise support agencies operating there (such as incubation and enterprise support facilities) and within the wider environment (such as Invest NI) could engage with emerging entrepreneurial potential and assist with the commercialisation of viable opportunities. Obviously, some entrepreneurial potential stemming from this effort may take time to develop and, thus, this strategy is long-term in focus.

Despite a growing urgency for change there are no quick fixes. Change is possible, and is already beginning to happening. However, to achieve lasting change there must be a sustainable long-term strategy, which integrates the efforts of both the Further and Higher Educational Institutions and the enterprise support agencies.

Universities have a valuable role to place in the process of culture change. The educational institutions can be seen as “the entrepreneurial propagators” who plant the seed and support the seedling, while the enterprise support agencies help nurture and grow the entrepreneurial
potential “budding” from our institutions. In this way, we can create a fertile environment, which will inspire and support a vibrant entrepreneurial culture.
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Abstract

The aim of this article is to evaluate the ratio of expenditures between fundamental research, applied research and technological development, to analyse this proportion in the innovation processes of Estonian biotech public sector and private SMEs, and to shape supportive measures to knowledge transfer and entrepreneurship in the biotechnology sector. The empirical study explores Estonian biotechnology by mapping the strategy, innovation processes and related expenditures of the public sector and private businesses. The author deduced the gross funding structure proportion of basic and applied research, and product/service development in Estonian biotechnology sector according to the formula: 11:5:1. The structure of research expenditures in the public sector mostly reflects the success of Estonian biosciences rather than the success of the biotech as an economy sector. Some options for improvement of sectoral system of innovation are given.

Keywords: knowledge transfer, innovation models, biotechnology, R&D expenditures, sectoral system of innovation.

1. Introduction

Life sciences have had long traditions in the University of Tartu since the 19th century, since the time of Karl Ernst von Baer (1792-1876) who was born in Estonia – “a Darwin scale scientist – who discovered the mammalian ovum and notochord, and established the new science of comparative embryology” (Raagmaa & Tamm 2004). There were more favourable circumstances supporting development of Estonian life sciences, incl. medicine, at the University of Tartu during the period of independence in 1918-1940. Later, one of the drivers of new academic competence creation was the decision of Soviet government about research in biotechnology as a sheltered industry in the 1970s. Several enterprises in the field were established in the 1980s, but these all collapsed before 1991 as having no market any more (Talpsep 2005). New biotech companies were established in the beginning of 1990s, during the re-establishment of Estonian independence. These new biotech companies were mostly in some way related to research institutions and universities in the start-up period, sometimes even longer. Technology transfer and commercialisation of research results from university to business has become very topical in the conditions of movement towards knowledge economy in Europe. In the comparison of two best practices of American and European universities, Stanford and Cambridge, the Stanford University and Silicon Valley is demonstrating the majority in creation of new knowledge-based businesses (Moore & Davis
Lower efficiency in socio-economic value-creation by European universities is evident also from other studies (Lambert Review 2003; Rodrigues 2002). This has raised the question about the change of universities’ mission in society. Over the last two decades, the traditional missions of universities – teaching and research – have been complemented by the third one – economic and social development of society. Adoption of the third mission by academia is called the second academic revolution (Etzkowitz 2004). For universities this means disclaiming the position of ivory tower and becoming a generator of economic wealth in society. The entrepreneurial paradigm of university in the triple helix of University-Industry-Government relations has become the concept leading to understanding of the innovation processes in knowledge economy (Etzkowitz et al. 2000). There are three well-known alternatives to transfer the achievements of university science into economy of the region (Lambert… 2003: 47; Audretsch, Thurik & Verheul 2002):

1. Spin-outs based on the new technological ideas from professors (from university);
2. High-level sales of licences for new technologies;
3. Knowledge spillover effects.

The two first ways presume research in the marketable field and the right understanding of real market needs and business opportunities, but also wide range of other preconditions supporting these processes. The third one is possible if the industry in the region or country has capability for knowledge, market or network spillovers, i.e. there is an implementation possibility of university knowledge in direct or indirect way. Altogether the efficient realisation of these alternatives means having favourable environment, which contains “infrastructure of people, business and legal processes, and financial and technical resources” (Bergeron & Chan 2004: 142). Shane describes these environmental influences on university spinoff activity via geographic location, access to capital, locus of property rights, rigidity of the academic labour market and industrial composition of the geographic area (2005).

The triple helix framework and the environment of knowledge transfer are the part of national innovation system (NIS) as well as the part of sectoral system of innovation (SSI). The influence of own national innovation environment on spin-off and knowledge transfer processes in a small country like Estonia should not be undervalued as besides the macroeconomic factors this contains the NIS (Marinova & Phillimore, 2003) and SSI (Malerba, 2004). The efficiency of university-industry public-private partnership in innovation processes is mostly depending on the principles of NIS where the government has the key role. The parliament has ratified the Estonian research and development strategy document “Knowledge-Based Estonia” (2002). However, this strategy document envisioned innovation and innovation support structures generally only as secondary to research and development (R&D). It has also been admitted that the ratio of expenditures between fundamental research, applied research and technological development (1:0.7:0.3 respectively; in further text also: R&D-ratio) is highly disproportionate, deviating sharply from the same figures in developed countries (ibid). What has given rise to that particular interpretation is not clear – the author was unable to find what is the basis of this concrete value for R&D-ratio. Other sources that do not distinguish between fundamental and applied research indicate that the ratio of R&D financing is 0.4:1 in Australia and 0.5:1 in the OECD countries (Lester, 2001). Another important question is the share of government and industry in R&D financing and how these sources are mutually related in a concrete (biotechnology) sector. In the USA government R&D investment made 27.8% and industry share was 66.3% of total financing sources. About 60% of government R&D funding in 2000 was spent on development, the remaining money was split almost evenly between basic and applied
research. (Bergeron & Chan 2004). Absence of this data about Estonia is the indicator that relevant information is lacking as is the innovation policy based on it.

It has been admitted that there is poor co-operation between research and the business sector in Estonia. Estonian companies mostly are not ready to finance (not only high-tech) R&D cooperation with university. This un-readiness is characterizing both partners: the industry as well as the university, which competences frequently do not cover the industry needs (Study... 2003). What should be impact of governmental intervention in this relationship is less studied. Even in more developed economies than Estonia, for example Australia, Portugal, Switzerland or Hungary, the share of government-financed business R&D exceeds 70% of the research budget (Lambert... 2003). At first glance the motivation of the university as the partner is depending on motivation and evaluation system of researchers and professors.

Usually the biggest part, about 75% of biotechnology results are the input for pharmacy industry (Bergeron & Chan 2004). But as in Estonia this type of pharmacy plants practically does not exist, there is very little space for spillovers also in other industries such as traditional agricultural and food industry in the region. Especially if we are comparing the number of graduates from the University of Tartu and from Tallinn University of Technology on bachelor, master and doctoral level prepared for working in the sector – about 125 graduates per year – then it is hard to find employers for graduates’ professional qualifications in Estonia, where we have about 200 jobs in research and a little less jobs in the industry, incl. personnel with lower than university level. The graduates can find good jobs in Finland, Sweden or in California, USA but not enough in homeland.

Therefore, the first two options of knowledge transfer remain topical in Estonia. The first way is related to the behaviour of individuals – entrepreneurs transfer university knowledge to business by establishing new companies. The other way consists in the creation of entrepreneurial climate in the university, enabling innovative capability and generating “economic wealth in society” by transferring university knowledge into functioning businesses. Academic entrepreneurship combines both ways. (Sijde 2002).

What might be the best conditions supporting university knowledge transfer? What should be the strategy of the NIS to realise the challenging goals? Here arises the problem of how to get relevant information, as generalised data from community innovation survey (CIS) and other general statistical databases, for example about expenditure on innovation as a share of total sales (Dynamising... 2002) are not sufficient for decisions to be taken in a concrete economy sector in a concrete country. Even the above-mentioned R&D share in the total innovation expenditure ratio is not trustworthy enough because of the lack of related studies in Estonia. The question about reliable international benchmarks and benchmarking methodology is critical (Lundvall & Tomlinson 2002).

The present article aims to evaluate the ratio of expenditure between fundamental research, applied research and technological development, to analyse this proportion in the innovation processes of Estonian biotech public sector and private SMEs, and to shape environment for knowledge transfer and entrepreneurship in the biotechnology sector, which has good prospects as a field of new knowledge economy.

Biotechnology was selected also for the reason that all main knowledge transfer and congruent innovation processes of the sector from basic research to commercialisation on the market are represented in Estonia. One cannot say the same about the others, in business meaning even more successful knowledge-intensive sector – the ICT sector, which is mainly represented by wide scale of companies from low to high value-added businesses, from subcontract-based production of electronic equipment to special business model based software design. Both ICT businesses are functioning without noteworthy basic scientific
knowledge development in the field in Estonia. The biotech sector is rather compact and consequently more readily accessible to empirical studies. Therefore, among other things, this article provides an opportunity to evaluate the agreement between the actual innovation model of the public and private sectors on the example of the Estonian biotech sector.

2. University Knowledge Transfer Environment, Innovation Models and Innovation Systems

All Estonian biotech companies are more or less related to universities and public R&D-institutions. As mentioned in the introduction, there are two main ways for commercialisation of the results of academic research: by knowledge (technology) transfer to either new start-up (spin-off) companies or to existing businesses (Sheen 2002). Both ways follow different routes before new technologies can be transferred to industry. On the one hand, the latter can be produced by undergraduate and post-graduate studies/research, by contract and collaborative research, by the creation of new strategic (technology) platforms, or on the other hand, simply by auditing and licensing previous R&D results (ibid). In both cases the university-company relations are usually regulated by a licence agreement. The current paper does not focus on different types of university spin-offs, the categorisation of which, as described by several authors (e.g., Rasmussen 2004; Smith & Ho 2005), is based on different knowledge transfer routes and ownership of start-ups. Herein the knowledge transfer is viewed as a phenomenon permeating all stages (phases) of innovation in society.

The (technology) knowledge transfer from university to industry is a process reframed by the actors and rules of the NIS. The latter determines the efficiency by which the R&D results are created and implemented in industry. It also contains questions concerning the ownership of intellectual property (IP) created in university, institutional autonomy, the existence of venture and risk capital, and other factors of economic environment (Smith & Ho 2005). Not less significant for developing academic entrepreneurship is the adoption of friendly entrepreneurial policies and culture supporting the commercialisation of the R&D results. Rasmussen distinguishes between the following stages in the spin-off process: the preceding conditions, opportunity identification, and pursuing the opportunity and new venture development (2004), thus specifying the interconnected components of the entrepreneurial process throughout the route of knowledge transfer. This permits us to conclude that knowledge transfer is the leading concept connecting both innovation and the entrepreneurial process.

The understanding of innovation covers the structure of products, services, production and management of organisation. Innovation is often seen as primarily related to products or processes. Product innovation increases the satisfaction level of a customer, while process innovation increases efficiency and productivity. Innovation is associated with creativity and generation of new ideas, their realisation through invention, R&D in general and development of a new product. (Business...2002). Technological innovation involves the innovation of both products and production processes (Kurik et al. 2002). Some authors have narrowly confined their concept of innovation to invention and its subsequent application (Ettlie, 2000). Paul Trott uses the notion of technical invention in an analogous definition (1998). A defining criterion for invention is its novelty. The definition of innovation, on the other hand, does not specify the criterion of novelty, nor does it mention where this idea originates from. In such a case any novelty in any particular place or context can be conceived of as innovation. At the same time, technological innovation is used here in its narrow meaning as some authors also include organisational (Clark 2003) and social innovation in that scheme. Most of the authors agree on innovation primarily being a process and not the result of a process (Trott 1998; Dundon 2002 and others).
It follows from the statements and writings of many researchers and participants in the innovation process in Estonia (*Knowledge-Based*... 2002; Köörna & Koljajeva 2000) that the prevailing innovation models are explicitly or implicitly linear. The most prominent among them seems to be the ‘technological push’ model, which originates from the post-WWII period (Trott 1998). The subconscious impact of this model on our thinking has been so profound that we usually take the validity of this simple scheme for granted, as experienced by D. Mahdjoubi in the USA (1997). This way of thinking is also evident in the aforementioned Estonian R&D strategy document. Any innovation deficiencies are thought to be compensated by simply beefing up R&D financing (*Knowledge-Based*... 2002; Köörna & Koljajeva 2000; etc.). A second-generation linear innovation model, which puts the emphasis on the needs of a customer, the so-called ‘market pull’ model, dates from the 1970s (Trott 1998).

The shortcomings of both linear models include inadequate differentiation between the processes from the perspective of technology and non-consideration of the feedback processes both within the given innovation chain and in the marketing and technological environment. Next, the third-generation model is known as the ‘coupling model’ (Rothwell 2002; Trott 1998). It takes into account the iterative process of successful innovation, regardless of whether it was triggered off by market or a technical idea (Ettlie 2000). A similar model is also the interactive innovation model of Rothwell and Zegveld; its further developments have been described by several authors (Trott 1998; Rothwell 2002; Mahdjoubi 1997). Such models represent technological innovation in relation to the needs of society and the development of technical and manufacturing environment. An interactive innovation model improved by the present author is presented in Figure 1.

*Figure 1. An interactive model of technological innovation (compiled and improved by the author from Rothwell 2002 and Mahdjoubi 1997)*

This model is characterised by reciprocal feedback between single processes and also between the processes and the environment. At the same time, it should be noted that these feedback loops not only represent the intermediary processes between an idea and a product,
but also with the environment where it all happens. A more differentiated innovation chain is also more consistent with the fact that many profitable improvements require no research at all and development takes place in the engineering and design phase (see shaded arrows in Fig. 1).

The fourth-generation integrated innovation model is roughly 10-15 years old. It is characterised by a parallel and integrated development process, which was for the first time applied by Japanese corporations, e.g. Nissan (Rothwell 2002). Everything between a market need and a new product entering the market – R&D, product development/improvement, product design, preparation for manufacturing the product, and getting the suppliers ready – occurs in a successive row of parallel processes. The simultaneous and early involvement of all participants in development significantly increases the efficiency of the implementation process. However, it must be conceded that such acceleration of the development process is not suitable for research-intensive production, where the product cannot be implemented without knowing the final result of R&D, e.g. in pharmacy and biotech.

The modern fifth-generation innovation process is based on systems integration and networking, in which the parallel development process has become an integrated process where the technology of technological changes is itself changing (Rothwell 2002). Such a process is characterised by general organisational integration, flexible and flat organisation structures and extensive use of ICT.

The innovation model which is oriented towards the external environment (partnerships, investments, acquisitions) is an open one and is characterised by the following features (Chesbrough 2003):

1. Not every ‘best brain’ works for us; we need the influx of knowledge and competence from outside.
2. External R&D create important value; internal R&D is partially necessary for preserving the imported value.
3. It is not necessary to start R&D oneself in order to capitalise it.
4. A better business model is preferable for being able to enter the market first.
5. We gain from the best application of both internal and external ideas.
6. We will profit from letting others use our intellectual property (IP) and we will purchase the IP of others whenever it is advantageous to our business model.

Realisation of different models of innovation is to a very great extent dependent on the business environment. A concrete business sector is characterised by its own market inherent to the field and enterprises interrelated with one another inside and beyond the regional and state boundaries. The sectoral system of innovation (SSI) includes boundaries and demand, knowledge and technology, actors and networks, and different institutions. Besides the processes described in Figure 1, sectoral aspects of innovation include the supply chain and non-firm organisations such as universities and other public and private organisations. The attributes of biotechnology are science, networks and divisions of innovative labour. Universities, venture capital and the national health system play the key role in the biotech sector of Europe. Special for European biotech is that university-industry links are less developed than in the USA (Malerba 2001, 2004).

The NIS is reasonable as a means of public policy intervention in market conditions, when the market mechanism fails to achieve the formulated objectives as it builds the ability to solve or mitigate the problem (ibid.). There is no final result to decide about the success of EU 6th Framework Program as a measure of the European innovation system (EIS) in biotechnology, for example, funding in research grants secured €2 million for Cyclacel based in Scotland. R&D expenditure made up about 60% (€4,571 million) of revenues in the Biotech sector in 2003 (Endurance… 2003). In the USA this indicator is much less – 45.7%
at R&D expenses $17,900 million (Biotechnology…). Ernst & Young see the trends that average losses (8% of the revenues in 2002) of public companies are declining (Endurance… 2003).

The regional biotech SSI is closely connected with the (local) NIS, but via supply and market chains the biotech companies extend far across the borders. That means openness of the business sector globally.

Public and private actors (universities and biotech companies) seem to be partners in the Estonian NIS. Is the open innovation model inherent in both main partners of the NIS? This raises the question about the correspondence between producing new scientific knowledge at universities and the knowledge needs of the companies in Estonia as well as abroad.

3. Methodology and sample

The empirical study had two main purposes: mapping biotech innovation processes (and expenditures) of the public sector and private businesses. Our interviews in SMEs permit us to draw some conclusions about their innovation models and strategies.

The public sector is carrying expenses related to the NIS as a whole, incl. regulatory systems, governmental agencies, IP-policy, universities, etc. (Knowledge… 2003). There are several sources of funding the budgets related directly to the biotech sector. The public sources of information are web-pages of the following institutions funding R&D:

1. Estonian Science Foundation – ESF,
2. Estonian Ministry of Education and Research – MoE,
3. Ministry of Economic Affairs and Communications (together with the Foundation Enterprise Estonia) – EE.

Where necessary, additional information was asked directly from the government agency.

The general statistical indicators of the biotech sector in Estonia are rather similar to its neighbouring countries around the Baltic Sea (Table 1).

### Table 1. Biotech companies around the Baltic Sea (data of Scanbalt http://www.scanbalt.org/)

<table>
<thead>
<tr>
<th>State</th>
<th>No of Biotech Companies</th>
<th>No of Biotech Companies per 100,000 inhabit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estonia</td>
<td>25</td>
<td>1.8</td>
</tr>
<tr>
<td>Latvia</td>
<td>28</td>
<td>1.2</td>
</tr>
<tr>
<td>Lithuania</td>
<td>26</td>
<td>0.7</td>
</tr>
<tr>
<td>Finland</td>
<td>120</td>
<td>2.3</td>
</tr>
<tr>
<td>Sweden</td>
<td>183</td>
<td>2</td>
</tr>
<tr>
<td>Norway</td>
<td>98</td>
<td>2.2</td>
</tr>
<tr>
<td>Poland</td>
<td>60</td>
<td>0.16</td>
</tr>
<tr>
<td>Germany</td>
<td>360</td>
<td>0.44</td>
</tr>
<tr>
<td>Denmark</td>
<td>100</td>
<td>1.9</td>
</tr>
</tbody>
</table>

The biotechnology sector is not homogeneous inside, there are several categorisations of the sector (Bergeron & Chan 2004). Hereby we are not using a detailed division of fields by the company. Most of the selected companies are biomedical businesses. Even the biomedical field itself has different sub-sectors. The total number of Estonian biotechnology
companies is small enough to determine the sample for study. The foreign-owned companies performing simple production and packaging operations of pharmaceuticals in Estonia were excluded, as they are not knowledge-intensive. Also were excluded very traditional biotechnology industries, for example, yeast production, and for the same reason, other food industries. The rest of the 25 (even more – 32 at the end of 2005, but seven of them just have registered and no data about economic activities in 2004) of registered firms were SMEs, from which 2/3 were related to the biomedical field. The companies that have no sales yet and whose businesses only mediate goods of foreign companies are excluded from the research sample. After excluding Egene Foundation as an exceptional one, 18 research-based biotech SMEs remained (Annex), 1/3 of them being spin-offs of the University of Tartu (Leego 2004). These are mainly (some of them – partly) research-based companies making 42.6% of total turnover and employing 66.3% of labour in the biotech sector. For mapping the innovation processes in companies, the annual reports were studied. The data about sales, investments into fixed assets and export markets were available from the reports. The annual report usually does not contain data about expenditure on innovation processes according to Figure 1. Also information about new trends in the business environment and other innovation factors such as IP and knowledge transfer are missing.

Therefore, a special questionnaire was designed for mapping managers’ opinion/evaluation and getting the data missing from annual reports:

1. relative share of expenses earmarked for innovation processes in their companies,
2. relations with the public innovation support system and the expediency of the support measures to the companies’ needs,
3. personnel strategy,
4. competences in the field of their own technology, product development, marketing and sales, (strategic) management etc.,
5. knowledge transfer, incl. openness of the innovation processes and networking in the fields listed above,
6. IP and patent pool.

The data were gathered by half-structured interviewing. This permitted us to get prompt answers to questions and specify concrete information about the company. The interviews and data collection were carried out by two master students, both managers at biotech companies. The quite comprehensive data gathered by researchers is only partly exhibited here in the paper.

4. Results and Discussion

In order to provide a better picture about R&D and other innovation processes in Estonian biotechnology the system of public and private funding was mapped according to the structure of a general model of technological innovation (Figure 1). The results are shown in Figure 1 and 2, and Table 2. The corresponding structure of innovation funding and expenditures by the public and private sectors are shown in Table 3.

Besides the above-mentioned funding institutions in Estonia there are the European ones that also finance biotech sector. Three of the interviewed companies have received support from EU projects as a partner. According to the information related by the Foundation Archimedes (Estonian… 2002), the Estonian partners’ share has been less than €100,000 in a 3-year period.

All Estonian biotech companies can provisionally be divided into three groups (Talpsep 2005): the first “wave” of companies was established 12-15 years ago, the second 5-
and the third 1-5 years ago. The findings about the Estonian biotech sector from the interviews with managers:

1. The companies are mostly profitable, but their own capability to invest into development is quite limited;
2. The sales of the Estonian biotech companies split between production and services almost equally;
3. The entrepreneurship and marketing experience in the companies was nearly three times lower (evaluation marks: 1.4-1.6) than research (4.7);
4. Attention to market development in biotech companies (sector) is growing; the number of marketing and sales personnel grew from 21 to 29 in the period 2002-2004;
5. The share of export in sales grew nearly 10% in the period 2002-2004;
6. Only a third of the biotech companies have adopted a growth-oriented strategy;
7. International knowledge transfer and networking is mostly related to research and practically not to commercialisation of research results;
8. Estonian partners are involved in basic and applied research (50-52% of the total R&D-expenses financed by SMEs), foreign partners less (5-7%); own participation of the companies is higher in product development (more than 75%) and product testing (54%).

The survey demonstrated the growing market-orientation and moving towards the open innovation model in Estonian biotech companies. The sales of the research-based companies have been growing with the rate 15-20 % per year, reaching more than 600,000 EEK/year per employee in 2004 (Figure 2).

Figure 2. Sales, value added and profit of research-based Estonian biotech SME-s, million EEK (the author’s calculations from annual reports)

The growth of total value added of sample companies has been 42 and 20 % in 2003 and 2004 (author’s calculations from annual reports). Profitability has been between 1 and 8 % of annual sales during the period 2001-2004. The total number of employees of the SMEs in the sample was 135.5 in 2003 and 134 in 2004 (from annual reports). Productivity measured as value added per person employed grew annually 31 and 21 % in the same period (Figure 3), reaching 246,100 EEK/year (appr. 15,700 EUR/year) at the average monthly salary 8,214 EEK (525 EUR) in 2004.
Figure 3. Value added and sales per employee in Estonian research-based biotech SMEs, thousand EEK (the author’s calculations from annual reports)

The preliminary evaluation of innovation expenditure structure of the Estonian biotechnology sector (Table 2) shows the prevailing role of public funding, which is about 80% of the total budget (can be even more if we take account all running EU projects). As one can see in Table 3 (Public expenditure) that 72.4 million EEK, i.e. 89% of public R&D expenditures were channelled for university research and only 2.9 million EEK had the aim to support private R&D in 2004.

Table 2. Structure of innovation funding of Estonian biotechnology sector (the author’s calculations from public information and managers’ estimations)

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Public funding</th>
<th>Private funding</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funder</td>
<td>1000EEK</td>
<td>1000EEK</td>
<td>1000EEK</td>
</tr>
<tr>
<td>Marketing &amp; Sales</td>
<td>EE 3206 29.7%</td>
<td>EE 7605 70.3%</td>
<td>EE 10811 10.0%</td>
</tr>
<tr>
<td>Production&amp;Infrastructure</td>
<td>EE 7795 72.1%</td>
<td>EE 3011 27.9%</td>
<td>EE 10806 10.0%</td>
</tr>
<tr>
<td>Prototype</td>
<td>EE 0 0.0%</td>
<td>EE 1038 100.0%</td>
<td>EE 1038 1,0%</td>
</tr>
<tr>
<td>Design &amp; Development</td>
<td>EE 0 0.0%</td>
<td>EE 4475 100.0%</td>
<td>EE 4475 4.1%</td>
</tr>
<tr>
<td>Applied research</td>
<td>EE 20001 84.2%</td>
<td>EE 33765 15.8%</td>
<td>EE 23631 22.0%</td>
</tr>
<tr>
<td>Basic research* MoE&amp;ESF</td>
<td>MoE&amp;ESF 55205 96.7%</td>
<td>MoE&amp;ESF 1862 3.3%</td>
<td>MoE&amp;ESF 57067 52.8%</td>
</tr>
<tr>
<td>Total per year</td>
<td>86207 79.8%</td>
<td>21756 20.2%</td>
<td>107963 100.0%</td>
</tr>
</tbody>
</table>

Note: *Allocations for doctoral studies are included in the biotech research allocation.

This support is not remarkable compared with Australia, Portugal, Switzerland or Hungary, where the share of government-financed business R&D exceeds 70% of the research budget (Lambert… 2003). This also demonstrates a predominance of basic research among other stages of innovation. From Table 3 one can deduce the ratio of gross funding structure of basic and applied research, and product/service development in the Estonian biotechnology sector being 11:5:1. Is this R&D-ratio the best solution for the NIS? In the business sector the ratio is approximately 1:2:2, and together with public support 1:3:2. As Estonian biotech companies are mostly profitable (see Table 2), then the budget according to the ratio 1:3:2 will provide for the existence of the firms in the short run. But is the industrial
R&D expenditure sufficient for the development of industry on the level of national strategic goals in the long run – this is the question about the national innovation strategy as a whole.

Table. 2. Structure of innovation funding and expenditure in the public and private sectors of biotechnology in Estonia in 2004 (the author’s calculations)

<table>
<thead>
<tr>
<th>Expenditure type</th>
<th>Public fund, Public expenditure, Public to Private support, 1000EEK, %</th>
<th>Private fund,Private expend. structure, 1000EEK, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fund, total</td>
<td>Public expenditure</td>
</tr>
<tr>
<td>Marketing &amp; Sales</td>
<td>3206</td>
<td>1400</td>
</tr>
<tr>
<td>Production &amp; Infrastruct.</td>
<td>7795</td>
<td>7795</td>
</tr>
<tr>
<td>Prototype</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Design &amp; Development</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Applied research</td>
<td>20001</td>
<td>17068</td>
</tr>
<tr>
<td>Basic research</td>
<td>55205</td>
<td>55205</td>
</tr>
<tr>
<td>Total per year</td>
<td>86207</td>
<td>81468</td>
</tr>
</tbody>
</table>

The gross public and private R&D expenditure (86,207,000 EEK) of the biotech sector exceeds the sales (83,144,000 EEK) of research-based SMEs in the sector. This is the first sign of the possible unbalance between the expenditure on research (financed by the Estonian tax-payer) and revenue on the society level. The growth rate of Estonian research-based biotech companies is of the same scale as that of American companies, but the businesses are much (10-100 times) smaller in size. There are more characteristics differentiating Estonian biotechnology from the industry of Europe and USA:

1. Low level of R&D expenses in Estonian biotech companies: 15.7% of revenues vs 60% in Europe and 45.7% in USA;
2. Profitability of Estonian biotech (small) companies;
3. Low level of venture capital (VC) investment in Estonian biotech;
4. Absence of own national pharmacy industry – one of the main target groups of the sector;
5. Weak connections between university research and companies’ R&D.

The first four aspects are discussed here, the fifth one – in the next section. The main reasons of these differences can come from several circumstances related to Estonian economic environment, policy and development so far. Estonian government has practised a liberal economic policy since 1992 and has provided only modest support to the companies of any business sector, incl. biotech. The main survival condition of the companies has been the balance between costs and revenues. Biotechnology is mainly the sector where outcome and results are feeding other bigger industries like pharmacy and healthcare in USA. These markets are too tiny in Estonia for formation of bigger companies without international sales. Low income of Estonian biotech does not ensure enough resources for creation and protection of new IP by SMEs. The short history of Estonian market economy has no examples of own business angels and venture capitalists become experienced in the sector although some of the companies have experience of using VC money. The comparatively modest business environment of the sector does not encourage foreign investors to enter the businesses as it has happened in ICT. The negative example of the slowdown of Estonian Genome Project after an active media campaign from the year 2000 has been retained. The risk and modest business environment of the sector has established the limits on further development. All
described factors are creating a closed circle of obstacles, which is very hard to break by SMEs without reasonable public support.

5. Conclusions and further perspectives

What might be the best way to commercialise the achievements of science? From two well-known alternatives, establishing spinouts and sales of licences on new technologies, the former involves the threat of dispersing resources. The result “is that too many spinouts have been created […] and that a large number of them will not succeed in the long term” (Lambert... 2003, p. 60). The quality and reliability of spinouts’ business plans will grow if private risk or seed capital is involved at an early stage of a new venture. Here the problem of a small amount of venture capital and angel investors can arise.

Successful licence sales have been achieved by universities boasting a high-level research and knowledge transfer system. Some of these universities have no own incubators and spinout system (Lambert... 2003). Some authors mention more success in knowledge commercialisation by using spin-off processes than by licensing (Rasmussen 2004; etc.).

Estonian biotechnology research institutions (for example, the University of Tartu) have very rare licence sales – 2-4 deals per year, and the sums are not remarkable by comparison with the expenses. Biotech research funding by the government is not balanced with the real business needs. These records can refer to two circumstances:

1. A low scientific level of biotech research in the Estonian universities.
2. Ignorance of market demand obstructs creation of new technologies with high commercial value.

The first speculation does not seem to be true as research funding and results evaluation are subject of deep quality control by various Estonian and European institutions. This statement is best justified by the fact that since 2000, several Estonian R&D institutions have been given the status of European centres of excellence. The other presumption is more probable as knowledge transfer is not a success indicator for university research. That means - the structure of research expenditures in the public sector mostly reflects the success of Estonian biosciences, not the success of biotech as an economy or business sector.

A simple linear forecast shows that approximately the same R&D financing structure as in the biotech sector of the U.S.A. in 2003 (45.7% of revenues) can be achieved in Estonia (together with the public sector if the sales continue to grow by 15% yearly) within seven or eight years. Taking into account the non-homogeneous structure inside the sector, as well as the lower relevance of public R&D and the Estonian biotech business, the period can be even longer. The economic efficiency of the biotech sector on society level cannot be achieved in the nearest 10-12 years. Estimated by the author, the R&D ratio 11:5:1 of the Estonian biotech sector describes the situation in even more unsatisfactory terms than the numbers in the strategy document about the national innovation processes altogether. From the previous analysis it is possible to suppose that the described R&D ratio describes clearly unbalanced situation of public R&D and education expenditures on society level. This is a quite normative approach, but it is difficult to establish the right ratio for Estonia. Obviously, the process of balancing R&D and innovation expenses, and expedient state budget is an iterative process, which needs its own strategy, policy and monitoring system on the state level. This presumes creating Estonian own competence centres for innovation and technology transfer research, and sectoral development. The conclusion drawn on the basis of the biotech sector is that there is no simple formula for the success of R&D-based businesses in a small economy.
The author’s opinion is that without remodelling the innovation processes and knowledge transfer (in the biotech sector as a whole), success can hardly be expected in the nearest ten years.

The challenges for the NIS and SSI to increase the efficiency of spin-off and knowledge transfer processes are as follows:

1. Adapting the public R&D expenditures more to the needs of the existing high-potential businesses at home and abroad;
2. Supporting Estonian companies’ global market capabilities;
3. Promoting entrepreneurial attitude at universities and other research institutions;
4. Supporting contract and collaborative research in remarkable proportions of the R&D expenditure;
5. Creating own structures to study and support spin-off processes in universities;
6. Creating own competence centres for research, monitoring and designing sectoral development and innovation strategies and policies.

The presumption for further development of the NIS is growing social capability to absorb new support measures and own sectoral monitoring and strategy research competence. Only own strategy competence of political decisions can assure well-balanced development in knowledge economy. Some steps have been taken towards improvement of the NIS. For example, the Estonian Enterprise has launched its Competence Centres Programme to develop joint R&D of business and research institutions. Some more steps are taken to raise the entrepreneurial spirit of researchers and adapt universities to business demand. For example, the innovation program SPINNO is directed towards creation of “a favourable entrepreneurial environment within the research and development institutions […] and applied higher educational establishments of Estonia” (The SPINNO… 2005).

Besides the efforts on the national level, the University of Tartu has launched additional measures to support spin-off and knowledge transfer processes, partly in the field of biotechnology. First, in 2001 the University established the Institute of Technology (IoT), which is responsible for contacts with regional companies, supports the commercialisation of scientific ideas of university faculty members and facilitates technology transfer. The new building opened in August 2005 contains three floors of laboratory space specially equipped for biotech development. Secondly, in 2002 the Faculty of Economics and Business Administration launched a master’s program “Entrepreneurship and Technology Management” targeted at students with experience in business, preferably in different technologies, incl. biotech. The program is oriented to international entrepreneurship training and involves international team of lecturers. Thirdly, at the initiative of the Faculty of Economics and Business Administration, the University of Tartu established an interdisciplinary Centre for Entrepreneurship. The mission of the Centre is to turn the University of Tartu entrepreneurial. The Centre is targeted at developing entrepreneurial and innovation education in the university curricula and facilitating the process of developing an entrepreneurial mindset among its faculty members and students. It is also aimed at the integration of university competencies in the regional and national innovation system.

The expectations about the outcome of different programs in the short run (three years) are very high. The results depend above all on the motivation and capability of the academic institutions (system) as a whole to change, i.e. this is the question about organisational and social innovation.

Endnotes

1 We can mention, for example, success stories of MicroLink (Closing… 2005) and Skype (Kaio 2005).
Hereby the author expresses his thanks to Indrek Kask, MSc, and Tiit Talpsep, MSc, for empirical data for the paper.

References


Dynamising National Innovation Systems, 2002, OECD.


Knowledge Flows and Knowledge Collectives: Understanding The Role of Science and Technology Policies in Development. 2003, Rockefeller Foundation.


ANNEX: List of Companies Studied

Applied Phenomics, Asper Biotech, Bestenbalt, Biodata, Bioexpert, Celecure, Iasgen, Immunotron, Inbio, Kevelt, Labas, LabExpert, Mikrotaim, Naxo, Prosyntest, Quattromed, Solis Biodyne, Torrosen, Visgenyx
STEM CELLS IN THE MEDIA: THE EMERGENCE OF PUBLIC UNDERSTANDING OF A NEW TECHNOLOGY

A. Najib Murad*, D.Jane Bower**, Julian, C. Sulej**

*Globalisation and Public Policy
Glasgow Caledonian University, Glasgow G4 0BA.
E-mail: najib.murad@gcal.ac.uk
Tel: (+44) 0141 331 3987 Fax: (+44) 0141 331 3293

** Centre for Enterprise Management
University of Dundee, Dundee DD1 4HN
E-mail: enterprise@dundee.ac.uk
Tel: (+44) 01382 344361
Summary

The failure of the introduction to Europe of GM foods illustrates how negative public perception of a novel technology can block the development of new products and services in spite of major corporate and governmental investment. Stem cell technology is a novel technology which holds out the promise of improved treatments for many major diseases. However stem cell research is a highly controversial area of life science. This is mainly due to the use of human embryos, which are one of the sources of stem cells. This has created barriers to the technology in many countries. (Cheshire, 2004; Nisbet, 2004; Knowles, 2004) but not, thus far, in the United Kingdom (UK), which has been at the forefront of the research with many scientific breakthroughs in the field of stem cells and cloning (Pfeifer, 2005; Sample, 2005).

This paper analyses media coverage of stem cells in the USA and the UK as an indicator of how, over a period of time, specific events may impact on the public discussion of a new technology and may ultimately affect public perceptions. The period covered in this study, from 1 May 2004 to 30 April 2005, was selected because it coincided with the run-up to the US Presidential Election where stem cells became an election issue (Hanson, 2004; Primack, 2004; Fox, 2004). The study found that the media during this period were focusing on economic opportunity and prospect rather than ethical issues associated with stem cell research. This differed considerably from the emphasis of media discussion of genetically modified (GM) foods during the previous decade which was associated with public unease and widespread concern particularly in Europe (Martin & Tait, 1992; Krimsky, 1998; Miller, 1999; Tait, 1999; Bower, 2005)

INTRODUCTION

Public concerns about the perceived risks associated with some technologies have had a significant impact on the commercial feasibility of these technologies. This has affected technologies as diverse a nuclear power and GM crops (discussed below). Stem cell technology is a recent addition to the list of controversial technologies which arouse pubic interest and media coverage.

Stem cells are unspecialised cells found in very small quantities in most living tissues which have the ability to self renew indefinitely and differentiate into mature cells with specialised functions (NIH, 2003; DoH, 2003; NRC, 2002). Although there are very considerable unresolved technical problems (Nature Biotechnology, 2005) scientists have identified major healthcare areas in which stem cells are likely to hold significant therapeutic potential: (1) degenerative diseases such as Parkinson’s, Alzheimer, stroke, heart disease, diabetes and arthritis (NIH, 2001; NRC 2002; Petersen and Terada, 2001; Keller and Snodgrass, 1999); (2) therapeutic applications in cell based therapies for spinal cord and other structural injuries, cancer, etc; and (3) drug discovery procedures to test the effectiveness and safety of drugs (Dayley et al, 2003; NRC, 2002; NIH, 2001; Keller, Snodgrass, 1999).

In spite of this great potential, stem cell research has always been surrounded in controversy leading to considerable discussion and ethical debate on permitting such research while preserving respect for human life (Cheshire, 2004; Nisbet, 2004; Knowles, 2004). Briefly, this is because the stem cell lines which are generally regarded as having most therapeutic potential are derived from human embryos. The stem cell debate is mainly focused on
whether embryo-derived cells should ever be used for therapy. The ethical justification of using embryonic stem cells derived from: (1) left over frozen embryos from in-vitro fertilisation (IVF) treatment; (2) embryos created for research purposes; and (3) therapeutic cloning; is often dismissed by opponents on one or both of the following grounds: 1. There are alternative techniques such as using adult stem cell from human somatic tissues or umbilical cord blood (NIH, 2001; Petersen and Terada, 2001). 2. It is unethical to use tissues derived through the destruction of human embryos even for therapeutic purposes (Cheshire, 2004; Nisbet, 2004; Knowles, 2004; Matthiessen-Guyader and Joliff-Bottrel, 2002). Proponents of embryonic stem cell justify their use as offering the best possible hope for patients (NIH, 2001; Vogel, 2001). In fact the focus on embryonic and not adult stem cell among scientific fraternity is because of the problem of using adult stem cells:

“…difficult to maintain them in undifferentiated state when grown in culture; they are rare and difficult to identify and purify” (NRC, 2002).

This has created a dilemma. On the one hand there are complex ethical, moral and social issues to be addressed:

“the moral status of embryos; the ethical conflict between using ‘spare embryos’ (embryos created for infertility treatment to enhance the success rate of in-vitro fertilisation (IVF) but no longer needed for this purpose); altruistic versus rewarded donations of gametes or embryos; patenting of human stem cells; and commercialisation of human stem cells”. (Matthiessen-Guyader and Joliff-Bottrel, 2002)

On the other there is the therapeutic and economic potential of embryonic stem cells. If they give rise to effective therapies, companies which develop them could reap the financial benefits associated with successful drugs, if the therapies are appropriable. Countries stand to reap the economic benefits of both successful companies and improved healthcare.

This summarises very briefly the controversy surrounding stem cell research. At the date of writing (March 2006) it has not been resolved, with different public groups taking different positions as to the permissibility of supporting human stem cell research, within and between countries (Knowles, 2004). In 2001 President Bush had severely limited the use of Federal funds for stem cell research on ethical grounds (Nature Biotechnology, 2001) a position which is unchanged today. The UK Government, on the other hand, has consistently taken a very positive view (Knowles, 2004).

**GM Foods**

This issue of public acceptability became particularly problematic in the case of GM Foods, where popular concerns created major hurdles, particularly in Europe (reviewed, Krimsky, 1999). Polls had shown that public doubts about GM foods were widespread among the European public well before field trials were carried out (Martin and Tait, 1992). When this stage was reached, action groups destroyed fields of trial crops (Fox, 1999). EU countries threatened to close their markets to GM foods (Financial Times, 1999). A controversial study which concluded that GM foods threatened the survival of the Monarch butterfly, an American icon, reawakened American concerns which had been quiet since the 1980s (Fox, 1999). One of the biggest US agri-trading businesses asked growers to segregate GM and
non-GM crops, which led to a great increase in costs (Tait, 1999). This led to loss of investor interest in this area of application. Small firms failed – Axis Genetics which used plants to produce human vaccine components, failed in September 1999 to raise £10m which was urgently required, and put itself up for sale (Fox, 1999). Large firms in the sector experienced falls in their share prices, and in some cases divested the parts of their business associated with GM foods. The company Syngenta (www.syngenta.com) came into existence in this way, divested by Swiss multinational Roche.

Both the processes by which the changes were made, and the products themselves, led to feelings of unease in some quarters (Barnes, 1999; Webster, 2002; Bower, 2005). This affected their acceptability and hence became another source of risk. There could only be an adequate return on the high levels of investment required for these developments from products which were approved and widely accepted in wealthy societies.

This risk also faces other novel technologies if an unfavourable discourse develops among public groups.

**Economic issues**

Biotechnology and pharmaceutical companies face high costs and risks to develop new therapies (Di Masi et al, 2003). The bursting of the IT ‘bubble economy’ in 2000 was the end of massive speculative investment in high technology companies, at least for a time (Klausner, 2005. Investors are currently more cautious and wary of claims of the potential for high return on technology investments. The combination of technical and ethical uncertainties associated with stem cell commercialisation, along with regulatory and legal difficulties, pose a formidable barrier to private investment in stem cell research at this time. Consequently there is a very limited availability of private finance to develop the technology.

However, thanks to the perceived economic benefits there have been some public initiatives, aimed at taking the technology forward to the point at which private investors would be willing to invest the substantial amounts required to take applications into routine therapeutic use. Singapore has committed massive public expenditure on biomedical science in general through government led initiatives: the National Biomedical Science Strategy, in which an estimated $2 billion is set aside over the next five years (Normile, 2002) specifically including stem cell research. Other countries have since developed their own initiatives. The United Kingdom is one of these countries as highlighted by Dorsey (2005):

“In contrast to the US - where federal funding for stem cell research has been curtailed by pro-life concerns - Gordon Brown said that he would make this a Keystone in building the UK's knowledge economy”.

Regulations, policy and government led initiatives such as the UK Stem Cell Bank (www.ukstemcellbank.org.uk/), UK Stem Cell Initiatives (www.advisorybodies.doh.gov.uk/uksci/) (e.g. UK Stem Cell Foundation (www.ukscf.org/) as well as regional government initiatives such as the Scottish Stem Cell Network (www.sscn.co.uk) and East of England Stem Cell Network (www.eescn.org.uk) coupled with a £2.5 billion government allocation for biotechnology until 2008 which include stem cell research reflect this desire to become global leader in research, science and knowledge based industries.
In spite of the lack of central government support in the USA, State governments in the USA are creating their own support mechanisms for stem cell research. For example California’s $3 billion initiative where public funds are being made available exclusively for promoting and supporting stem cell research in the state through the California Institute for Regenerative Medicine (CIRM) over next 10 years, equating to $300 million a year (Check, 2005). The fear of losing scientists to other states has seen others taking immediate action countering this. States in the US such as Connecticut, Massachusetts and New Jersey are passing or have passed laws allowing them to fund stem cell research (Reinberg, 2005; Oransky, 2004). Other countries too have realised the economic importance of stem cell research. Australia, China, Japan, Sweden and South Korea are among the countries that have committed federal funds and developed national initiatives in stem cell research (Du, 2005; Jia, 2004; De Trizio and Brennan, 2004; Sleeboom, 2002).

The level of governmental support into stem cell research is an indicator of the importance placed on the potential of stem cells as an economic generator. But it remains to be seen whether the public in all these jurisdictions will be willing to support research which is perceived by some to compromise the ‘respect for human life’ especially when it may be years from clinical application.

Focus of the study

It is not proposed in this paper to explore further either the technical or ethical issues surrounding stem cell technology. This study focuses on the emerging public understanding of the significance of stem cell technology in the UK and the USA. It analyses the US and UK media coverage of this area in the year following April 2004, as a reflection of public perceptions of this new and controversial technology and its potential for society.

BACKGROUND

Role of the media

It has been argued that media has always played an important role in the advancement of technologies. According to Turney (1998), scientists:

“…began trying harder to influence or control the public image of science in the media outside their own hands – attempts which have gone on ever since”.

One model of policy making described the media’s role in the policy process as that of a key disseminator of scientific information (Lomas, 2000). This model described how information is generated by researchers and then disseminated by advocacy networks and the media. It is then picked up by individuals formally involved in the policy process, such as government officials and those informally involved such as citizens and stakeholder groups. However, Lomas (2004) further stated that:

“It is these purveyors who turn information into common knowledge”.
This explains the role the media have in disseminating information, particularly scientific information, to the public. Another view of the media is that of Christensen (2004: 26), where his study described the media as:

“…*de facto* extensions of the state-corporate-military complex and their function is to (directly or indirectly) smooth the way for US commerce and government policy”.

This is why the media are considered an important tool in dissemination of information. However, the interpretation of this information is influenced by the value systems of the individuals receiving the information (Wilson et al, 2004). For example, acceptance increases if the research is linked to potential therapeutic applications which confirms the suggestive power of expectations of cures and therapies (Pompe et al, 2005).

Media reporting cannot be given all the responsibility for influencing public acceptance. The public too can influence the way news is reported and presented in the media. Newspapers are in the business of selling news and as such their reporting of news must meet their readership’s expectations and interest, which is part of the explanation for selective reporting. The media cannot force people to read newspapers if they do not wish to. This is reflected in the current climate of declining newspaper readership leading to content revising, changes to the layout and creating special supplements targeted at the readership (Raeymaeckers, 2004).

Cultural and historical events influence news reporting in the media (Molina, 2004). In the 1960’s, scientific and technological ‘breakthroughs’ and ‘revolution’ were all the rage in news reporting but this changed in the 1970s to concerns about ‘risks’. In the 1980s, the enthusiasm of the 1960s re-emerged and the old clichés about ‘breakthroughs’ re-emerged (Nisbet and Lewenstein, 2001; Nelkin, 1995). The media again underwent another phase in its news reporting where:


However one looks at it, journalism plays an important role because:

“..it can reinforce the authority of science in society [by providing] scientists with unique opportunities to defend and augment their authoritative position in society” (Zehr, 1999).

Valiverronen (2004) noted that biotechnology regularly attracts media interest:

“… modern biotechnology meets most of the criteria for a good news story.”

The public interest generated by stem cells has been registered and possibly influenced through media coverage. The situation may be compared with the media strategies, representation and audience reception of the AIDS crisis studied by Miller, Kitzinger and Williams (1998) where they found that:

“… media has proven to be an effective lobbying arena where public policy is defined and played out”.

Valiverronen (2004) noted that biotechnology regularly attracts media interest:
This can be seen in current media interest in stem cell research. Much of the coverage is favourable, in the category which Mulkay (1993) described as a ‘rhetoric of hope’, portraying an optimistic view of science as progressive and offering future benefits to health and society. It has been credited with the potential to transform lives fundamentally, carrying great health and economic promise. However this promise is accompanied by the suggestion of potential danger (Valiverronen, 2004). The perception of potential for danger echoes Mulkay’s alternative view of science, the ‘rhetoric of fear’ (1993):

“A pessimistic view of science the public has towards embryo research where ‘mad scientists’ are ‘out of control’, morality is declining and social disintegration threatens”. (Bower, 2005)

It is this “rhetoric of fear” that had a profound effect on the GM debate. The negative view presented in the media by anti GM activists created a sense of fear within the public:

“The discourse was dominated by the ‘rhetoric of fear’ demonising the technology.” (Bower, 2005).

The ability to influence and inform the public is an important attribute of the media. Studies have shown that knowledge of scientific, ethical and legislative aspects of stem cell research is correlated with media coverage (Nisbet, 2004). It has also been suggested that media coverage of stem cells influences public opinion and impacts on the way we think (Petersen, 2002; Kitzinger, 2000; Condit, 1999). For example, amid the coverage of President Bush’s restrictions on federally funded stem cell research in August 2001, 60% of US citizens felt they were well informed about the topic. That figure however, dropped to 28% within a few weeks and a further 17% a year later (Nisbet, 2004). The steady decrease was correlated with the declining media coverage of Bush’s stem cell stance.

**METHODOLOGY**

This raises the question of what press coverage since 2000 indicates about the evolving public perception of stem cell technology in the USA and the UK, and whether there have been critical events which have impacted on the rhetoric The objectives of this paper were:

1. to identify US and UK newspaper articles featuring stem cells in the headlines,
2. to categorise the articles by the nature of their coverage.
3. to identify key events within the period April 2004-5 which may have impacted on public perception of stem cells.

As discussed earlier in this paper, the analysis of news reports of stem cell research gives an indication of readers’ opinions. While media content is not a direct indicator of public opinion, it does reflect and therefore can reveal deep seated cultural values (Gan, 1980). This proposition is adopted in the analysis employed in this study.

**The selected newspaper and articles**

The newspaper articles were obtained from eight major newspapers in the UK and US: (1) The Daily Telegraph; (2) The Guardian; (3) The Independent; (4) The Times; (5) USA Today; (6) The New York Times; (7) The Wall Street Journal; and (8) The Washington Post.
All newspapers selected included their Sunday equivalent. These newspapers were selected based on having these criteria: (1) national distribution (UK only); (2) large circulation figure; and (3) middle class/professional readership. The circulation figures were obtained from Audit Bureau of Circulations (www.abc.org.uk; www.accessabc.com) which is shown in Table 1.

<table>
<thead>
<tr>
<th>Newspaper</th>
<th>Circulation Figure (approximate average figure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Daily Telegraph</td>
<td>1,545,595</td>
</tr>
<tr>
<td>The Guardian</td>
<td>754,876</td>
</tr>
<tr>
<td>The Independent</td>
<td>395,142</td>
</tr>
<tr>
<td>The Times</td>
<td>2,011,936</td>
</tr>
<tr>
<td>The New York Times</td>
<td>1,680,582</td>
</tr>
<tr>
<td>USA Today</td>
<td>2,612,946</td>
</tr>
<tr>
<td>The Wall Street Journal</td>
<td>2,070,498</td>
</tr>
<tr>
<td>The Washington Post</td>
<td>1,000,565</td>
</tr>
</tbody>
</table>

Table 1: Circulation figures of selected newspapers (Source: Audit Bureau of Circulation as at 31 March 2005)

The readership data was obtained from National Readership Survey (NRS; www.nrs.co.uk) and Audit Bureau of Circulation (www.accessabc.com). Demographic of the readership in UK and US is illustrated in Figure 1 and Table 2 respectively.

![Figure 1: UK Newspaper Readership Demographic](image)

Table 2: USA Newspaper Readership Demographic (Source: Audit Bureau of Circulation, March 2005)
The level of education and social status influences newspaper readership as the work of Chan and Goldthorpe (2005: 46) found:

“..education does indeed influence newspaper readership and on lines that would be predicted under the information-processing hypothesis, controlling for education does not remove the effects of status”.

The articles were then identified using search facility of: (1) Lexis Nexis Professional; and (2) the respective US newspaper online archives. Key phrase used in the search was ‘stem cell’ and the search was limited to return only results containing ‘stem cell’ in the headline of all newspaper articles. Every effort was made to ensure that all articles with stem cell in the headline were included. The results were checked to ensure no repeat stories (same articles with different spelling of stem cell such as stem cell, stem cells, stemcell, stemcells, stem-cell, and stem-cells). A total of 273 articles with stem cell in the headline were obtained; 86 from UK newspaper and 187 from USA newspaper. Letters to the editors were also included in the sample as this represented an interaction process between the public and the respective newspapers. The articles obtained were then categorised into categories reflecting their subject areas. Decisions about categories were made after reading the whole article. A judgment was made on the basis of the narrative as a whole as to the category into which it fitted. Where there was some overlap in terms of coverage between more than one category, the dominant category was selected.

Categories

The articles were then categorised into subject areas:

1. **Economic** referred to news reports on public and private investment; funding; job creation and unemployment; labour movement; intellectual property (IP) ownership; and economic generation (or regeneration).
2. **Ethics** referred to articles covering public concern about stem cell research; government and international ethics initiatives; ethical consideration of the research; and discourse or ethical debate on stem cells.
3. **Letters to Editors** referred to the letters sent to newspapers and these were taken to be indicators of the level of interest or response from the public in stem cells.
4. **People** referred to news reports concerning public figures (non-scientists) prominently featured in relation to the field of stem cell research. This included people who were either for or against the research.
5. **Politics and Policy** referred to news reports covering policy and guidelines; also politics and elections (such as the US Presidential Election and UK General Election).
6. **Science** covered scientific and technological breakthroughs and achievement in stem cell research; also scientific issues affecting the development of the research.

**Period of study and events**

The period covered by the search was from 1 May 2004 to 30 April 2005 during which there were many significant developments in areas concerning stem cell research particularly political events, scientific advancement, ethical issues and economic matters. These events
are discussed further in the next section highlighting events that might have had an impact on news reporting.

**Methodological limitations**

One limitation was the possible subjectivity of the researchers in categorising the articles. Another methodological problem was that headlines only were used to identify news reports. The actual number of articles with ‘stem cell’ in the main body of the articles might be more than that gathered. The choice of newspapers in this study raises another issue. The criteria used for the selection was based on NRS for UK and the ABC for USA. The NRS claim to be:

“… a non-profit-making but commercial organisation which sets out to provide estimates of the number and nature of the people who read Britain’s newspapers and consumer magazines. Currently the Survey publishes data covering some 250 newspapers, newspaper supplements and magazines” (Source: www.nrs.co.uk).

Their methodology and survey technique of the readership is open to interpretation. Other limitations are the ownership and political affiliation of a selected newspaper which have considerable influence on the news it reports. This view is shared by Herman and Chomsky (1988), Altschull (1995), Bogart (1995) and Parenti (1993) who viewed media size, corporate ownership and advertising as the most important factors in shaping news output. This was minimised by selecting several journals which held well-known, differing political stances. A final point is that the Letters to Editors, whose publication is under editorial control, might not be representative of the actual number of responses from the public.

**RESULTS**

273 newspaper articles were examined with US newspapers producing 187 and UK newspapers 86. Figure 2 shows the total number of articles published by each paper over the period studied.

![Figure 2: Numbers of stem cell headlined articles published in the UK and US named newspapers between 1 May 2004 and 30 April 2005](image-url)
As Christensen (2004) has concluded:

“…the number of articles only tell one side of the story while the other is to be found in the analysis of the emphasis placed on certain stories vis-à-vis others”.

Table 3 shows the number of articles in each of the categories identified in each of the US and UK papers.

<table>
<thead>
<tr>
<th>Publication</th>
<th>Economics</th>
<th>Ethics</th>
<th>Letters to the Editor</th>
<th>People</th>
<th>Politics &amp; Policy</th>
<th>Science</th>
<th>Total Number of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Daily Telegraph and Sunday</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td>Telegraph</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Guardian and The Observer</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>The Independent and The Independent</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>on Sunday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Times and The Sunday Times</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>The New York Times</td>
<td>13</td>
<td>3</td>
<td>24</td>
<td>3</td>
<td>22</td>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>The Wall Street Journal</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>14</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>The Washington Post</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>43</td>
<td>13</td>
<td>63</td>
</tr>
<tr>
<td>USA Today</td>
<td>5</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>18</td>
<td>28</td>
<td>15</td>
<td>106</td>
<td>70</td>
<td>273</td>
</tr>
</tbody>
</table>

Table 3: Categories and numbers of articles published in UK and USA newspapers

The category with the most articles published in both UK and US newspapers is Politics and Policy with 106 articles (19 in UK and 87 in USA). This is followed by Science with 70 articles; Economics with 36 articles; Letters to Editors with 28; Ethics with 18 and People with 15 articles.

Events shaping the news

A number of events occurred during the period of study which were linked in the articles to stem cell technology. These are described, with date of occurrence, in Table 4. In some cases these were events whose outcomes would facilitate the technical developments. However, events which triggered public discussion also have the potential to influence the development of the public debate about stem cell technology. The launch of the UK Stem Cell Bank in May 2004 was the first stem cell bank in the world offering scientists the ability to:

“…provide a repository for human stem cell lines of all types, and will be developed to supply well characterised cell lines under appropriate and accredited quality
systems both for basic research and for the development of clinical applications” (Source: UK Stem Cell Bank website www.ukstemcellbank.org.uk).

<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2004</td>
<td>First Stem Cell bank launched in UK and 2 stem cell lines created in the UK were the first to be deposited.</td>
</tr>
<tr>
<td></td>
<td>New Jersey became first state in the US to support stem cell research through its Stem Cell Institute of New Jersey with initial public fund of $6.5 million and $20 million of private funding.</td>
</tr>
<tr>
<td>5 June 2004</td>
<td>Former US President, Ronald Reagan dies.</td>
</tr>
<tr>
<td>August 2004</td>
<td>Scientists at Newcastle University’s Centre for Life granted first UK cloning licence to create human embryonic stem cells.</td>
</tr>
<tr>
<td>10 October 2004</td>
<td>Christopher Reeves dies.</td>
</tr>
<tr>
<td>November 2004</td>
<td>US Presidential Election.</td>
</tr>
<tr>
<td></td>
<td>Californians voted for Proposition 71 allowing stem cell research to be conducted and raising of £3 billion over 10 years to fund the research.</td>
</tr>
<tr>
<td>20 January 2005</td>
<td>George W. Bush takes the oath of office.</td>
</tr>
<tr>
<td>February 2005</td>
<td>HFEA granted therapeutic cloning license to study motor neuron disease to Roslin Institute.</td>
</tr>
<tr>
<td></td>
<td>UK Stem Cell Foundation supported by the Prime Minister with £100 million funding was proposed by Prof. Sir Christopher Evans.</td>
</tr>
<tr>
<td>16 March 2005</td>
<td>UK 2005 Budget announced with new initiatives (e.g. UK Stem Cell Initiatives) to boost science and innovation with stem cell taking centre stage.</td>
</tr>
</tbody>
</table>

Table 4: Heavily reported events within the period of study

In May 2004 New Jersey became the first US state supporting stem cells through its Stem Cell Institute of New Jersey with $6.5 million public funds and a further $20 million private funding for stem cell research. This paled in comparison with the California initiative passed by public vote in November where $3 billion of public funds were committed over ten years for stem cell developments. These initiatives signify the frustration of scientists and States with Bush’s stance against stem cell research. This frustration was also borne out during the US Presidential Election where the newspaper reports indicate that stem cell research became an election issue. The death of former US President, Ronald Reagan, and the actor Christopher Reeves in June and October respectively, contributed to the call for federal support for stem cell research in USA.

Newspaper reports document the granting of the UK’s first therapeutic cloning licence to scientists at Newcastle University’s Centre for Life in August 2004 as well as another licence to Roslin Institute in February. The awarding of both licences highlighted the importance the UK was placing on stem cell research.

These events had an impact on the number and content of articles in newspapers. Four significant peaks are visible in Figure 2. The first peak occurs in June 2004, followed by a second peak starting in July 2004 and reaching its maximum in August 2004. This is followed by a third in October and the final peak occurring between January 2005 and March 2005.

The first peak corresponds to reports of the death of former US President, Ronald Reagan. Stem cells received wide coverage in these reports due to his death from Alzheimers and because his wife was a key proponent of stem cell research among the Republican in US. The second peak corresponds to reports of the death of another prominent proponent of stem cell research, the actor Christopher Reeves. The US Presidential Election in November was the
main contributor to the increase in articles in the third peak while the final peak was mainly due to two events: (1) the interest generated with tabling of stem cell bills in Maryland, Massachusetts and New Jersey State Assembly; and (2) in the UK newspapers, the tabling of UK Budget.

Three US newspapers (The New York Times, The Wall Street Journal, and The Washington Post) showed significant peaks in August, mainly due to the support of Bush’s stem cell policy by Laura Bush. There was a large increase in the number of Letters to the Editor in The New York Times commenting on this news. The Presidential Election caused the increase in all newspapers in the period from October to November. Another significant contributor to the increase in this period was the Californian Proposition 71 and also the granting of the first UK cloning licence to Newcastle University.

The final increase can be attributed to the coverage of another cloning licence awarded to the Roslin Institute, and to UK government support for stem cells which included £100m funding being made available in the UK budget in March 2005.

**DISCUSSION**

The numbers generated in this study are not large enough for rigorous statistical analysis. However they do give some indication as to the associations being made by the media in relation to stem cells, and their relative importance, in the USA and the UK.

One event influenced news reporting relating to stem cells more than others both in the UK and the USA: the US Presidential Election. However, there were clear differences between the US and the UK reporting of both Politics and Economics which indicated that the categories had rather different scope in the two countries. The UK press revealed a fairly even view of stem cells as an area of economic interest, generally supported by politicians of all parties. The perceived economic opportunity presented to the UK by the Bush policy, which could allow the technology to advance in the more permissive climate of the UK while it was impeded in the USA, was evident in UK newspapers reporting of stem cell research. This raises an interesting point that suggests stem cell research is overwhelmingly seen in the same light by all major political parties in the UK, and presumably then by most of the public: as offering a clear economic prospect and potential to cure diseases. For this reason, and in contrast to the US Presidential Election, the run-up to the UK General Election did not offer the same level of political debate on stem cell research. The unveiling of the UK 2005 Budget with a clear focus on making stem cells a contributor to the UK economy was never challenged by the party in opposition.

The US reporting of the US Presidential Election focused on the conservatism of the Bush administration. Bush’s policy on stem cell research caused considerable conflict between political parties. Interestingly it even met with some opposition within his own Republican Party. This opposition was reported in all the articles in the People category of this study. Most articles commented on proponents of stem cell research such as Nancy Reagan, Michael J. Fox, Christopher Reeves and Arnold Schwarzenegger with a couple of articles on opponents of stem cell research, in particular Barbara Bush.

Bush’s position was viewed by scientists as stifling the development of stem cell research in USA. The anxiety caused by his conservatism on stem cells resulted in individual states in the
US developing their own initiative for stem cell research. More states in the US are now actively seeking to table bills allowing them to undertake their own stem cell initiatives which they see as a necessity to counter the impact of California Proposition 71. As one article stated:

“At the very least, competing States are trying to keep their own researchers from migration to the West Coast. (Mansnerus, 2005).

Not only was stem cell technology regarded as an economic prospect but it was also seen as a pre-emptive strategy to prevent the lost of highly skilled labour.

The most interesting development identified by this study was the low level of discussion of ethical issues (except indirectly, inasmuch as the Bush position was taken on ethical grounds) in both UK and US newspapers. The fact that there were only eighteen articles (four in UK and fourteen in US newspapers) directly concerned with ethics out of a total of 273 suggests that the media interest was mainly focused on the economic and health outcomes of the research. As discussed above, the media position is likely to reflect public views. Hence this suggests that there was widespread public acceptance in the USA of stem cell research as a desirable activity. Although the US official stance on stem cell research, which has been on political rather than purely ethical grounds (McGee, 1999) has been different from that of the UK, public attitudes do not appear to be as divergent.

The only category that was reported more in the UK than the US was Science. The focus on scientific news in UK newspapers may be attributed to the clear indication from UK government, in the words of UK Prime Minister, speaking about the 5 year plan of the Department of Trade and Industry, of the intention to:

“..become the world leader in stem cell research, biotechnology etc”. (http://www.number-10.gov.uk/output/Page6596.asp)

This statement, associated with the award of funds for research, cell banks and regulatory approval of cloning research indicates the strength of UK government commitment to develop the technology.

CONCLUSIONS

Nisbet (2004); Petersen (2002); Kitzinger (2000); and Condit (1999) found that media coverage influences public opinion and impacts on the way people think. In the light of their conclusions, the results of this study suggest that the science and technology associated with stem cells are currently perceived by the UK public, and to a large degree by the US public, primarily as economically significant activities. The number of letters published in the wake of the deaths of both Ronald Reagan and Christopher Reeves gives an indication of the level of public interest in the therapeutic potential of stem cell research. It also illustrates how media coverage can be positively or negatively influenced by current events, which in turn impacts on public perceptions.

The perceptions reported here in relation to stem cell research differ markedly from the very negative UK public perception of GM crops reflected in media discussions during the previous decade (Martin & Tait, 1992; Krimsky, 1998; Miller, 1999; Tait, 1999; Bower,
In this case public opinion became so hostile that it has proved impossible to deploy GM crop technology in the UK. At present it appears that a favourable rhetoric has developed around stem cells in the UK, and to a large extent in the USA, even though the current US government has put barriers in the path of development. However, public attitudes can change. It cannot be concluded that the opposition to the technology may increase. For example, if clinical trials showed adverse effects outweighing clinical benefits the current positive perceptions might wane.

The high number of Science related articles may be a sign of a change in public mood towards a higher level of expectation of benefits from technology than has recently been the case, particularly in the UK. The media may be starting to focus on science and technology ‘breakthroughs’ as they did in the 1960s. Nisbet and Lewenstein (2001) have discussed the enthusiasm for technology in the 1960s, and also a relative increase in media focus on the ‘economic prospects and progress’ of science and technology in 1995 and 1996. The evidence presented here also suggests that newspapers may be less preoccupied with risks, ethics, public accountability and controversy than they were in the period 1997 to 1999 (Nisbet and Lewenstein, 2001). If confirmed by further research this would indicate an interesting change in the trends of recent years.

Further research is planned to analyse the text discussed here in more depth utilising content analysis. The study will also be extended to include media coverage in continental Europe, Australia and Asia.

References


DEVELOPMENT OF A BEST PRACTICES FRAMEWORK FOR NEW PRODUCT DEVELOPMENT IN SMALL TO MEDIUM ENTERPRISES

John Nicholas, Ann Ledwith

Department of Manufacturing and Operations Engineering, University of Limerick, Limerick, Ireland.

Tel: 353 61 213271, Fax: 353 61 338171, john.nicholas@ul.ie ann.ledwith@ul.ie
Abstract

The successful development of new products and services is crucial to the long-term survival of business enterprises. With increased competition to the market place and shortening product life cycles pressure has been imposed on all enterprises to innovate more efficiently. This paper presents the development of an initial best practice framework for new product development (NPD) within Small to Medium Enterprises (SME’s). The initial framework was developed based on Kahn’s model (Kahn, Barczak et al. 2004; Kahn, Barczak et al. 2006) and an extensive review of currently recognised NPD Best Practises. The model was refined using the Delphi method with a panel of experts including academic personnel within the University of Limerick and various other professionals. In addition to refinement of the model the question of whether or not large and small companies can be examined using the same framework was posed to the panel of experts.

1.0 Introduction

Current research and literature on best practises within New Product Development (NPD) almost exclusively focuses on the processes and practises used within large firms (Cooper and Kleinschmidt, 1995; Kahn, Barczak et al., 2006). However, according to the European Commission, within the enlarged European Union of 25 countries, 23 million SME’s provide 75 million jobs and represent 99% of all enterprises. (Commission 2003). A best practises framework for New Product Development tailored for SME’s would therefore prove invaluable.

The initial framework was developed using Kahn’s model (Kahn, Barczak et al. 2004) and a broad review of the management of SME’s (Welsh and White 1981; Ghobadian and Gallear 1997; Voss, Blackmon et al. 1998) as well as research into currently recognised NPD Best Practises (Cooper and Kleinschmidt 1995; Griffen 1997; Loch 2000). The model was refined using the Delphi method; a technique, based on a structured process used for collecting and distilling knowledge from a group of experts by means of a series of questionnaires(Adler and Ziglio 1996). For this research the panel of experts included academic personnel within the University of Limerick and professionals working on the Champions of Innovation programme, which, is funded by the Irish state-sponsored body Enterprise Ireland to encourage innovation in SME’s in Ireland. Each professional has been involved for many years in innovation management and is recognised as an expert in their field.

The Why and How of Benchmarking

Companies develop many types of new products ranging from radically new projects to minor extensions of existing products. A company’s potential to successfully develop new products depends on the type of products they wish to introduce, the processes they use and their relationships with parties outside the company including competitors, customers, distributors and suppliers. Various factors have an impact on firms NPD potential. Some of the factors, identified in the literature, which potentially impacts the NPD of a firm, include:

- Rapidly changing market environment (Carlson 1994; Slattery and Nellis 2005).
- Shorter Product lifecycles (Baynus 1994; Judge 1997).
In response to the dynamic environment in which firms operate various methods are employed to improve process efficiency and overall NPD effectiveness. Benchmarking which is defined as “the process of identifying, understanding and adapting outstanding practices from within the same organisation or from other businesses to help improve performance” (Cook 1995) is one method used. The use of Capability Maturity Models (CMM) to benchmark a company’s performance is of huge benefit (Camp 1998; Paulk 1998) as it evaluates performance and suggests direction for process improvement.

**Maturity Models**

A Capability Maturity Model (CMM) is an organisational model, which describes using a number of levels or stages, the way in which an organisation manages its processes. Each maturity level is a well-defined plateau, which provides a foundation for the next level resulting in continuous improvement. A maturity model usually encompasses:

- A number of levels.
- A label for each level, e.g. initial level, optimising level etc.
- A broad description of each level.
- A number of Key Process Areas (KPA) for each level.
- A description of how each KPA should be performed at each maturity level.

CMM’s have been proposed for a range of activities including Quality Management (Quality Management Maturity Grid, (QMMG), Software Development Capability Maturity Model (SW-CMM) and Project Planning Maturity Model (PP-MM).

**2.0 Best Practices within NPD Key Process Areas (KPA)**

The first step to improving a firm’s development process is an understanding of the critical success factors, which influence the success rate of new product development. A clearer understanding of these factors, which drives product success, allows a firm to focus their valuable R&D resources to the essential stages of NPD.

This section discusses these critical success factors as recognised in the literature. NPD best practices are discussed across 6 Key Process Areas (KPA) as defined in Kahn’s model (Kahn, Barczak et al. 2006): strategy, portfolio management, process, market research, people and metrics & performance evaluation. Each Key Process Area (KPA) is described across 5 levels of sophistication with each level corresponding to a particular set of characteristics describing: poor practice, (Level 1-Initial), improved practice (Level 2-Under Development), good practice (Level 3-Defined), excellent practices (Level 4-Managed) and best practices (Level 5-Optimized).

**Strategy**

A firm’s NPD strategy defines the role new product development plays in the firm and must be closely aligned to the overall organisational strategy. A clear product development strategy allows management plan and allocate the necessary resources required to achieve the goals within the plan. A clearly communicated new product development strategy has been cited by various researchers as vital to excellence in new product development (Booz, Allen et al. 1968; Booz, Allen et al. 1982; Cooper and Kleinschmidt 1995; Pittiglio, Rabin et al. 1995; Martensen and Dahlgaard 2000). A benchmarking study by Cooper and Kleinschmidt
(1995) found several differences in the strategic plans between the “best” NPD performers and the “worst” NPD performers. The best performers were found to have; a clearly communicated strategy with long-term focus, well defined goals and clearly defined areas of strategic focus. The worst performers in comparison had a weak, poorly communicated, short-term strategic plan with no defined goals or specified arenas of strategic thrust.

**Process**

Using a formal NPD process has long been cited as a differentiating factor between success and failure with in NPD (Booz, Allen et al. 1968; Booz, Allen et al. 1982; Cooper 1990; Zirger and Maidique 1990; Page 1993; Brown and Eisenhardt 1995; Griffen 1997a; Voss, Blackmon et al. 1998; Ayyagari, Beck et al. 2003). Zirger and Maidique (1990) found that new product success was greater when R&D was efficiently planned and well executed and when there was interaction and co-ordination between R&D, production, marketing and other functional groups. Voss, Blackmon et al. (1998) found the best performing firms were those who “developed more formal planning” while Brown and Eisenhardt (1995) concluded that successful product development is a result of “careful planning”.

Implementing a stage-gate® type process may also lead to improved product success rates and the product being faster to market (Cooper 1994; Mercer Management Consulting Inc 1994). Cooper et al. (2002b) also found that progressive firms use the stage-gate® process as a risk management model. A company may use a fast track process with fewer gates for low risk projects and utilised the full stage-gate® model to remain in control of larger high-risk projects.

Quality of execution of the process is also viewed as critical to project success (Zirger and Maidique 1990; Cooper and Kleinschmidt 1995; Cooper and Kleinschmidt 1996; Griffen 1997a). Zirger and Maidique (1990) concluded that product development is more successful if processes are planned and implement fully and project planning should include: “all phases of the development process; research, development, engineering, manufacturing, and market introduction”. Cooper and Kleinschmidt’s (1995) extensive benchmarking study revealed that the best NPD performers had a “high quality new product process” where there was a focus on quality of execution and the process was complete.

Pre-development work is viewed as crucial to the success of a NPD project. Researchers concur that the completion of “upfront homework” has a positive impact on product development (Booz, Allen et al. 1968; Booz, Allen et al. 1982; Kuczmarski & Associates 1994; Cooper and Kleinschmidt 1995; Cooper 1996; Langerak, Hultink et al. 2004).

**Metrics and Performance Evaluation**

Unless a firm measures their NPD performance it is difficult to assess whether they are improving or declining in NPD performance. Measurement of NPD performance leads to improved product success (Cooper and Kleinschmidt 1987; Pittiglio, Rabin et al. 1995; Griffen 1997a; Voss, Blackmon et al. 1998; Martensen and Dahlggaard 2000; Godener and Soderquist 2004). Griffin (1997) found that the best practice firms set formal financial objectives against which actual performance can be evaluated. This leads to higher expectations regarding NPD and thus an increase in NPD performance. Voss Blackmon et al. (1998) established that the best small firm performers in NPD were the firms, which were “systematically keeping performance data”. Godener and Soderquist (2004) concluded that measurement of NPD performance resulted in “better coherence and relevance of product
portfolios, reorienting projects before failure, deciding on corrective actions, supporting the launching decision, enhancing staff motivation, and facilitating well-balanced decision-making”. Performance measurement is not something, which is done as a once during the development cycle but as continuous occurrence. The processes and performance need to be regularly and formally monitored throughout the life of the project (Cooper and Kleinschmidt 1987).

**People**

The manner in which the personnel charged with the task of NPD are organised can influence the success of NPD. The idea of using cross-functional teams to develop new products as opposed to a department silo method has been supported by the majority of researchers (Little 1991; Page 1993; Brown and Eisenhardt 1995; Cooper and Kleinschmidt 1995; Pittiglio, Rabin et al. 1995; Cooper 1996; Griffen 1997a). Brown and Eisenhardt (1995) found that successful product development depends on the processes being implemented by “a competent and well co-ordinated cross functional team”. Griffin’s (1997) best practice investigation concluded that the best practice firm’s use multi-functional teams more “extensively” than the poorer performers. Cooper and Kleinschmidt’s (1995) in-depth analysis of best practices utilised by the “best” and “worst” NPD performers yielded valid and clear results regarding the use of cross-functional team players. Their findings demonstrate that the use of cross-functional team’s in NPD result in a better performance especially if; every project has an assigned team of players, the team is cross functional, all projects have an identifiable and accountable team leader, the leader and the team are accountable for all facets of the NPD project — from beginning to end.

Visible top-level management is recognised as vital to success of any project, (Kuczmarski & Associates 1994; Brown and Eisenhardt 1995; Cooper and Kleinschmidt 1995). Brown and Eisenhardt (1995) state that success is possible only “with the blessing of senior management”. Cooper and Kleinschmidt (1995) conclude that product success will improve if senior management is strongly and visibly committed to the development of new products, devote the necessary resources, are intimately involved in key go/kill decisions.

Communication between the people and departments involved in NPD also effects product success (Keller 1986; Cooper and Kleinschmidt 1995; Voss, Blackmon et al. 1998). Voss, Blackmon et al. (1998) found the best small NPD performers were the ones who were “more open internally, paying attention to employee communication”. Cooper and Kleinschmidt (1995) identify that high quality development teams require frequent meetings for efficient decisions and co-ordination.

The presence of a champion on a project team has been identified as a asset and important factor leading to project success (Chakrabarti 1974; Cooper and Kleinschmidt 1987; Markhan and Griffen 1998; Lee, Lee et al. 1999)

**Portfolio Management**

Portfolio management represents the screening out of product concepts to identify preferable concepts with which to proceed. Effective portfolio management is vital to successful product innovation (Griffen 1997a; Cooper, Edgett et al. 1999; Cooper and Edgett 2001a; Cooper, Edgett et al. 2004b). Several practices has been associated with good portfolio management by Cooper, Edgett et al (1999, 2004b) including maximising the value of the portfolio, prioritization of certain projects, seeking balance in the portfolio in terms of a number of
parameters e.g. long-term projects vs. short-term projects, strategically aligning your portfolio with the overall organisational strategy and having a formal systematic management system in place to select the correct projects and allocate necessary resources.

**Market Research**

A firm's effectiveness in market information gathering, processing, sharing and use of market information plays a pivotal role in determining the success or failure of its new products. According to Zirger and Maidique (1990) it is critical that the firm “Understands user needs and effectively translates these needs into solutions for the customer”. A strong market and customer orientation, where the firm focuses on the needs and wants of the customer will result in more successful projects (Cooper and Kleinschmidt 1995; Martensen and Dahlgaard 2000). Effective market research particularly in the early stages of development results in sharp product definition (Cooper and Kleinschmidt 1995). There are two key stages to the early stages of market research prior to the beginning of development. The “scoping stage” which entails a preliminary market, technical and business assessment followed by “building the business case which involves a deeper study includes a user wants study, competitive analysis along with technical and manufacturing assessments. Incorporating these two key stages to the NPD process will result in sharper product definition, which is a critical success driver (Cooper and Edgett 2001a).

While it has been necessary to divide the each of the best practices in the six separate KPA this does not mean that the practices apply to that section explicitly. Senior management for example is categorised in the people KPA however for NPD to be successful senior management support is required in every aspect of the process. Support is required for an effective strategy to be developed, for good portfolio management as well as in-depth market research.

**3.0 Methodology**

The Delphi methodology is described as “a systematic method of collecting opinions from a group of experts through a series of questionnaires in which the feedback of the group’s opinion distribution is provided between question rounds” (Helmer 1972).

A questionnaire was developed containing exploratory questions regarding the framework and distributed with a copy of the proposed NPD Maturity Model to each member of the panel. Each KPA was allocated one page in the questionnaire. The characteristics were listed and a column entitled “PDR”. Which allowed the respondent “Promote…Demote. …or Remove” the characteristic from that level. Space was also provided for additions to each level and general comments.

Open-ended questions were added at the end of the questionnaire to explore the following issues:

1. Can large and small companies be examined using the same framework?

2. If both large and small firms can be analysed using the same framework then does there exist a point on that framework that represents the optimal level for an SME or should the company be continually striving to reach the highest maturity level?
4.0 Development of the Model

Strategy

Figure 4.1 presents the five levels of sophistication for strategy. Companies at Level 1 do not define any NPD strategy and have a short-term view of NPD. As a company matures to Level 3 the NPD strategy has been defined although it may still be vague in parts. The defined strategy is aligned with the companies overall strategy. Once they reach level five an SME has a clearly defined long-term strategy and organization wide awareness of the strategy and a company is continually reviewing and updating its NPD strategy to ensure it is in line with the organizations strategy and to reflect changes to the market place. A complete description of the characteristics from Level 1 to 5 can be viewed in figure 4.1.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Under Development</th>
<th>Defined</th>
<th>Managed</th>
<th>Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>No NPD strategy</td>
<td>Unclear NPD strategy</td>
<td>NPD strategy has been defined but may be vague in parts</td>
<td>Clearly defined NPD strategy</td>
<td>Clearly defined strategy with organisational awareness of the strategy</td>
</tr>
<tr>
<td>Short-term view of NPD</td>
<td>Some NPD projects are aligned with NPD strategy but in general do not fit</td>
<td>NPD strategy mostly aligned with organisations mission statement</td>
<td>NPD strategy clearly aligned with organisations mission statement</td>
<td>Mission and strategic statement define strategic arenas for new opportunities</td>
</tr>
<tr>
<td>NPD not recognised as being crucial to long-term survival of organisation</td>
<td>NPD strategy not in line with overall organisational mission statement</td>
<td>Most NPD projects are aligned with NPD strategy allowing a certain amount of flexibility</td>
<td>All NPD projects are aligned with NPD strategy unless they were approved by senior management</td>
<td>NPD strategy is continually being reviewed and updated to be kept in line with the organisations strategy and to reflect changes to the market place</td>
</tr>
<tr>
<td>Availability of funding drives project selection</td>
<td>NPD projects are identified during budget process and resources allocated accordingly</td>
<td>NPD strategy can be redirected in real time to respond to market forces</td>
<td>Quantitative goals for NPD</td>
<td>Long-term strategic view of NPD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organisational mission and NPD strategy drive NPD project selection</td>
<td>Strategic plan identifies arenas of opportunity</td>
<td></td>
</tr>
</tbody>
</table>

Process

Figure 4.2 shows how a company develops its processes to move from Level 1 up to Level 5 on the maturity model. A Level 1 company does not have any process in place for NPD. As a company improves it processes it moves through level 2 and 3 to a position where formal processes have been installed. If further improvement occurs the company were to reach level five of the maturity model they are in the situation where one formal stage-gate® process is utilised across the entire organisation for the NPD process and the company is continually striving to improve it NPD process. A complete list of the characteristics from Level 1 to 5 can be viewed in figure 4.2.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Under Development</th>
<th>Defined</th>
<th>Managed</th>
<th>Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>No NPD process exists</td>
<td>Informal processes exist for some stages of the NPD process.</td>
<td>Formal process exist for NPD and are utilised for most projects</td>
<td>Formal process exist for NPD and are utilized for every project</td>
<td>One formal stage-gate® process is utilised across the entire organisation</td>
</tr>
<tr>
<td>NPD is unorganised and ad-hoc</td>
<td>Process can be easily circumvented</td>
<td>NPD process documentation is available</td>
<td>Stage-gate® process may be employed however the process or gates may not be clearly defined and may vary across the organisation</td>
<td>Go No-Go criteria are clearly pre-defined before each gate</td>
</tr>
<tr>
<td>No NPD process owner</td>
<td>No set process with different groups using their own processes</td>
<td>Champions may play a role but are not critical to success</td>
<td>The NPD process is also flexible and adaptable to meet needs of individual projects</td>
<td>Personnel are well disciplined in using to process to develop ideas</td>
</tr>
<tr>
<td>No project champion</td>
<td>Little documentation exists</td>
<td>Idea generation is structured and formal</td>
<td>Time critical projects may skip stages of process</td>
<td>Organisation is striving to continually improve its NPD performance</td>
</tr>
<tr>
<td></td>
<td>A project champion is vital to project success</td>
<td>One individual can be clearly identified as the process owner</td>
<td>The NPD process is visible and well documented</td>
<td>Improvement of the process is the responsibility of management as well as the project teams</td>
</tr>
</tbody>
</table>
Metrics and Performance Evaluation

Figure 4.3 portrays a continuum that ranges from a company having no standard criteria or metrics (Level 1) to a position where there are formal processes in place for evaluating projects and are used in most cases (Level 3) to a situation where there is a company-wide set of metrics used for every project (Level 5). Again the most mature level is when a formal stage-gate® process is utilized to evaluate the projects as they move from one stage of development to another. A more detailed breakdown of the characteristics can be viewed in figure 4.3.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Under Development</th>
<th>Defined</th>
<th>Managed</th>
<th>Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>No standard criteria for evaluating projects</td>
<td>There are some general principals for evaluating projects however most are informal in nature</td>
<td>There are formal processes in place for evaluating projects and are used in for most projects</td>
<td>Quantitative goals have been set for the company NPD performance</td>
<td>There is a standard set of criteria for evaluation individual projects</td>
</tr>
<tr>
<td>No criteria for evaluating overall NPD effort</td>
<td>Revenue is predominant metric for NPD success</td>
<td>Team approach is used to evaluate and make final decisions</td>
<td>Scoring models checklists are used to evaluate projects</td>
<td>There is a standard set of criteria for evaluation of overall NPD effort</td>
</tr>
<tr>
<td>Projects never killed</td>
<td>Performance may only be measured at the end of the project</td>
<td>Projects can be killed at any stage of development</td>
<td>Senior management and project team responsible for projects evaluation</td>
<td>A formal stage-gate® process is utilized to evaluate the projects as they move from one stage of development to another</td>
</tr>
<tr>
<td></td>
<td>One person does all the evaluations</td>
<td>Performance measured at various stages of the project</td>
<td>Management must approve really new ideas or big projects</td>
<td>There is a group charged with the task of evaluation</td>
</tr>
<tr>
<td></td>
<td>Some projects may be killed</td>
<td>Variables such as lead time, project schedule slippage are tracked for projects</td>
<td>Multiple review points exist</td>
<td>Metrics are used to continually improve the NPD process</td>
</tr>
</tbody>
</table>

Figure 4.3 Key Process Area: Metrics and Performance Evaluation

People.

The people KPA shows the transition from Level 1 on the model where there is departmental silo organisation and NPD is performed by individuals to a point where NPD teams have been formed (Level 3) and finally to the situation the existence of cross-functional teams is the factor, which drives project success. Figure 4.4 shows a complete list of the characteristics.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Under Development</th>
<th>Defined</th>
<th>Managed</th>
<th>Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPD is performed by individuals</td>
<td>NPD is decentralized within each department</td>
<td>Departmental liaisons lead to established NPD teams (multifunctional team)</td>
<td>Cross functional teams under for the NPD process and are vital for project success</td>
<td>Each project has a core team which remains on the project from beginning to end</td>
</tr>
<tr>
<td>Individuals are unorganised</td>
<td>A champion may shepherd projects and are essential for project success</td>
<td>Teams have regular meetings to discuss progress to discuss NPD project</td>
<td>NPD is team-focused</td>
<td>A NPD group exists and is purely dedicated to NPD work</td>
</tr>
<tr>
<td>No Project leaders</td>
<td>Some people are employed full-time for NPD</td>
<td>Each NPD project has a project leader</td>
<td>Identifiable new product managers within business department</td>
<td>Project management software and techniques used to manage Projects</td>
</tr>
<tr>
<td>Personnel take on too many projects</td>
<td>No NPD teams but personnel are employed from a range of different departments</td>
<td>Champions may exist but they are not necessary for project success</td>
<td>Clearly identifiable project leader who accept ownership of the project</td>
<td>Ongoing NPD training provided</td>
</tr>
<tr>
<td>No identifiable NPD team</td>
<td>Little or no training given</td>
<td>Training given to people employed fulltime in NPD</td>
<td>Not all projects required to go through project group: some may be handled by departmental manager</td>
<td></td>
</tr>
<tr>
<td>No training given to people involved in NPD</td>
<td>Creativity by people not directly involved with NPD may be stifled</td>
<td>Personnel limit number of projects they work on</td>
<td>Training given to people involved in NPD</td>
<td></td>
</tr>
<tr>
<td>Prevalent departmental silos</td>
<td>Management become aware that structure amongst the personal is important for project success</td>
<td>Creativity within the organisation encouraged</td>
<td>Team accomplishments recognised and rewarded when performance is exceptional</td>
<td></td>
</tr>
<tr>
<td>“Over the wall” technique is used between department where one department completes their section of a project and passes it on without any consultation with other departments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.4 Key Process Area: People

Portfolio management

Level 1 companies have no processes in place for portfolio management as seen in figure 2.5. As a company matures it reaches a point where Formal portfolio management processes are
in place and are utilized for most projects (Level 3). Finally once a firm has reached level five there is a formal and systematic portfolio management process is in place with organizational awareness of the system. A company at Level 5 is continually reviewing their portfolio management process in effort to improve its success. A more detailed breakdown of the characteristics can be viewed in figure 4.5.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Under Development</th>
<th>Defined</th>
<th>Managed</th>
<th>Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>No processes in place for portfolio management</td>
<td>Some portfolio management processes are in place though most are in formal nature</td>
<td>Formal portfolio management processes are in place and are utilised for most project</td>
<td>Formal portfolio management processes are in place and are utilised for every project</td>
<td>A formal and systematic portfolio management process is in place with organisational awareness of the system</td>
</tr>
<tr>
<td>Portfolio management is responsibility of individuals</td>
<td>Management have realised importance of good portfolio management</td>
<td>Management are visibly involved in portfolio management</td>
<td>Management can be made available should an opportunity arise on the horizon</td>
<td>A mix of techniques are used to ensure a prioritization of certain projects</td>
</tr>
<tr>
<td>No concern over types of projects being developed</td>
<td>Financial techniques are only method used to assess a products financial return</td>
<td>Portfolio management is responsibility of project team and management</td>
<td>The organizational NPD strategy drives NPD project selection and thus most projects are aligned with the organisational strategy</td>
<td>Keen consideration is given for balancing the number of projects and the available resources</td>
</tr>
<tr>
<td>No projects prioritized</td>
<td>Some projects are aligned with the organisational strategy</td>
<td>Scoring techniques utilised to calculate a projects feasibility, risk strategic alignment etc</td>
<td>Mapping techniques may be used to assess feasibility of a project. These mapping techniques allow trade of between factors e.g. risk vs. profit</td>
<td>Organisation is continually reviewing their portfolio management process in effort to improve its success</td>
</tr>
<tr>
<td>No consideration given to Organisation mission/strategic statement when undertaking NPD projects. Projects may or may not be aligned</td>
<td>NPD projects prioritization occurs during budget process and resources allocated accordingly</td>
<td>Some projects may be prioritized by senior management</td>
<td>All projects are aligned with the organisational strategy</td>
<td>There is a balanced variety of projects in the portfolio</td>
</tr>
<tr>
<td>Ability to secure funding drives Project selection</td>
<td>Pet projects exist</td>
<td>The organizational NPD strategy drives NPD project selection and thus most projects are aligned with the organisational strategy</td>
<td>NPD projects are treated as one portfolio</td>
<td>An idea bank exists</td>
</tr>
<tr>
<td>No balance in NPD portfolio</td>
<td>A variety of projects supported with little regard to balance in portfolio</td>
<td>Attention is paid to the type and mix of products being developed</td>
<td>Pet projects exist only if approved by senior management</td>
<td></td>
</tr>
<tr>
<td>Pet projects are prevalent</td>
<td>NPD projects are reviewed individually</td>
<td>Pet projects exist only if approved by senior management</td>
<td>NPD projects are reviewed by category or type</td>
<td></td>
</tr>
<tr>
<td>Projects are never killed</td>
<td>NPD projects are reviewed individually</td>
<td>Pet projects exist only if approved by senior management</td>
<td>NPD projects are reviewed by category or type</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.5 Key Process Area: Portfolio Management**

**Market Research**

Figure 4.6 presents a situation where an immature company at Level 1 does not undertake any type market research. By Level 3 formal organised market research of some form is undertaken for most projects. Once a company has reached Level Five they are optimising their research as they attempt to anticipate its customer’s future needs through continuous market research. Figure 4.6 shows a complete list of the characteristics from Level 1 to 5.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Under Development</th>
<th>Defined</th>
<th>Managed</th>
<th>Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>No market research performed</td>
<td>Management realise possible benefits of market research</td>
<td>Senior management takes keen interest in market research.</td>
<td>Product definitions are based on market research</td>
<td>Concept testing, product testing and market testing are consistently undertaken and expected in every projects</td>
</tr>
<tr>
<td>No Customer/user input in NPD</td>
<td>Market research is still ad-hoc and informal</td>
<td>Market research is budgeted</td>
<td>A formal market research function exists in the organisation</td>
<td>Market studies are on going</td>
</tr>
<tr>
<td>No concept testing, market testing of any kind is undertaken</td>
<td>Market research is reactive in nature.</td>
<td>Market research used to develop product definition before project commences</td>
<td>Market research performed for all NPD projects</td>
<td>Market research is continuous process even after product launch</td>
</tr>
<tr>
<td>No studies undertaken to gain knowledge regarding market place</td>
<td>Market research only performed in some cases</td>
<td>Market research more organised and formal in nature</td>
<td>Primary and secondary techniques are utilised</td>
<td>Organisation attempts to anticipate customers future needs through continuous market research</td>
</tr>
<tr>
<td>Pet projects are prevalent</td>
<td>Basic Market research is performed but only after a project has already begun</td>
<td>Market research more proactive in nature</td>
<td>Concept testing, product testing and market testing used in most projects</td>
<td></td>
</tr>
<tr>
<td>Focus limited to current organisational needs</td>
<td>Evaluation of actual research results are poor</td>
<td>Market research of some variation is performed for most projects</td>
<td>Customers form an integral part of NPD process</td>
<td></td>
</tr>
<tr>
<td>Evaluation of actual research results are poor</td>
<td>Research performed is generally secondary in nature</td>
<td>Some primary market research undertaken</td>
<td>Strict Go/kill/hold/recycle criteria exist</td>
<td></td>
</tr>
<tr>
<td>Pet projects still exist</td>
<td>Qualitative research techniques are utilised</td>
<td>Concept testing, product testing and market testing used in some projects</td>
<td>Go/kill/hold/recycle criteria exist based on market testing results</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.6 Key Process Area: Market Research**
5.0 Results and Discussion

While a full analysis of the questionnaire results is beyond the scope of this paper. The respondent’s comments and suggestions to improve each KPA of the model are discussed as well as their opinions on the examination of large and small firms using the same model.

Strategy

NPD strategy represents defining and planning a focus for the NPD efforts of the company. One comment made by a respondent was the words “goals” and “strategy” were used and interchanged throughout the KPA. As these represent the same thing the model should utilise only one to avoid confusion and ensure clarity. It was also pointed out that in the lower levels it is not the availability of funding which drives project selection rather “pet projects drive project selection”. The setting of quantitative goals for NPD is another issue raised which the respondent’s felt could be expanded across the levels into what type of quantitative goals are being set at each level.

Process

Process represents the processes the company uses to move a project through for idea generation to launch. One respondent felt the role of “documentation” is hugely important to the success of a project and this was conveyed strongly though the process KPA but was lacking in the other KPA. They felt a documented process for performance evaluation and portfolio management in particular is vital. A contradiction within Level 4 was also noted by several consultants. The characteristics included that a stage-gate® type process may be employed but gates may not be clearly defined and may vary across the organisation. However also stated is that the NPD process is visible and well documented resulting in disagreement between the characteristics.

Metrics and Performance Evaluation

Metrics and performance evaluation correspond to how NPD performance data is measured, reported and stored. The respondent’s agreed that communication of the data is important for current and future project success. The theme of communication of the data is relatively weak across the 5 levels and needs to be addressed. Also having evaluations and multiple review points is important but the quality of these reviews is more important to ensure that weaker projects are killed. Another respondent pointed out that having data measured, stored and accessible for future projects does not mean that the data will actually be accessed and used by the team members so a discipline needs to exist at more mature levels to ensure employees are aware the data exists for use and draw on the available information.

People

Several issues were raised by the respondent’s regarding the people KPA. Firstly is the issue of co-location. One respondent through their research had found that if the people involved in NPD were located close together it had impact on project success. Being located close together resulted in more meeting and increased communication and awareness of the issues surrounding the project. They also raised the issue “generalist vs. the specialist”. They had found that generalist was on to many project teams and did not devote their time evenly between the projects but only to the project they prefer to work on or been seen to be working on. However the majority of the consultants agreed that it rarely happens that an individual
limit the number of teams they are a part of. It was also cited by several of the experts that senior management support across this the KPA and in several other KPA’s was not strong enough considering its huge role in NPD success.

**Portfolio Management**

Portfolio management represents how a company screens its product concept to decide which concepts to proceed with. One respondent noted that their was slight variation between the portfolio management KPA and the strategy KPA regarding senior managements level of control of projects existing which are not aligned with the company’s strategy showing a slight inconsistency between the KPA’s. Several of the respondent’s were also confused with regard to the treating of NPD projects are treated as one portfolio. This was intended to signify that when a project was being chosen the overall portfolio was consulted to ensure that balance would be maintained with regard to high risk vs. low risk projects, radically new vs. incremental projects etc. One respondent also had a general opinion regarding this KPA and whole model. Some items appear at lower levels and then skip a level and reappear at a more mature level. They suggested a “continuum of improvement across each KPA” e.g. the prioritization of projects is not mentioned in Level 4.

**Market Research**

The main issue raised regarding market research by the respondent’s was the customer’s involvement. Customer involvement appeared at level 1 then skipped two levels and reappeared at a more mature level. It may be argued that during those levels market research is being carried out and market research usually captures the voice of the customer however for clarity and consistency in the model a continuum should be seen across all levels. Another respondent questioned that the model does not take into the consideration how radical products can evolve without market research. Finally one respondent suggested the possibility to allow time for research after product has been launch. This gives time for research into technologies, which evolved during the development of the product and their applicability to the current product. The team is also held together for a period of time allowing in case there is an engineering change order (ECO).

**Applicability of Model to Large and Small firms**

Whether or not both large and small companies can be assessed using the same framework was a key issue explored in the questionnaire. Out of the 6 returned questionnaires 3 respondent’s thought it was possible and 3 respondent’s thought separate models were required. Of those who thought it was not possible there was various reasons. One consultant stated “small companies are not large companies shrunk down; they need separate and distinct models and analysis”. The same consultant even saw within the thresholds of the SME definition (Commission 2003) a need for two models as through their research companies with approximately less than 80 employees often has no defined departments. They thus saw the need for separate models to analyse small companies and medium sized companies. Another respondent saw “context as a crucial limiting which drives/challenges NPD. This context includes resources (financial, skill, time) which handicaps SME’s”. The fact that organisational structure is dependant on organisational size was raised by another 3 respondent e.g. “the decision cycle is much faster in small companies”.

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Those who thought it were possible they had various arguments. One respondent concluded that the NPD processes for a large and small firm “are the same even if the implementation is different”. Another respondent raised an interesting perspective. They thought the same levels and characteristics in principal would apply e.g. in a small company there may only be 1-2 people in an NPD team yet these could bring multi-functional thinking e.g. a technical person with marketing skills (Level 5- optimised) or they could be silo-thinking (Level 1-initial). With regard to whether an SME should be continually striving to reach the highest maturity level or should they aim lower than level 5 all respondents except for one agreed that all companies large and small, should aim for optimisation”. The respondent who disagreed concluded, “going to level 5 would not give a return proportional to the effort required to attain it”.

6.0 Conclusion

The proposed framework is an initial attempt at organising existing benchmarking data from published studies into a maturity model for NPD in small to medium enterprises. It was designed to initiate discussion amongst experts as to what represents “a best practice” to small firm. Initial findings have presented a wealth of information to refine and tailor the model for an SME. The consultants are divided as to whether or not the same model can be used to assess large and small firms. Kahn’s model is designed with large companies in mind and the fact that this model needs changing to suit a small company would suggest they cannot be assessed on the same model. Further investigation and an expansion of the Delphi panel should yield additional results allowing the completion of the framework.

7.0 Notes

Stage-Gate® process is a conceptual and operational road map for moving a new-product project from idea to launch. Stage-Gate® is a widely employed product development process that divides the effort into distinct time-sequenced stages separated by management decision gates (Product Development Institute Inc 2006)

8.0 References


The Strategic Planning-Environment-Performance Relationship Re-visited in HTSFs

Nicholas O'Regan*, Martin A. Sims** David Gallear ***

Middlesex University Business School*
Hertfordshire University Business School**
Brunel Business School***

* Corresponding author  N.O'Regan@mdx.ac.uk
Telephone 00 44 208 411 6162

Nicholas O'Regan is Professor of Strategic Management at Middlesex University Business School. His research interests include the organisational culture, leadership and the strategic planning processes of small and medium sized organisations.

Martin Sims is Senior Research Fellow at Hertfordshire University Business School. His research interests include the advancement of competitive advantage in manufacturing SMEs.
The Strategic Planning-Environment-Performance Relationship Re-visited in HTSFs

Abstract

Recent research has shown that the degree of strategic planning within a company has a significant impact on performance of HTSFs. However, external operating environmental threats are often ignored or at best marginalized by firms, often leading to a negative impact on corporate performance.

This paper develops and tests a methodology using a number of characteristic footprints to represent the emphasis on strategic planning, financial performance and the observance of external threats from the operating environment. The footprints are used to assess the link between the variables and overall corporate performance. The paper uses a new approach to multi-variate analysis based on the conditional formatting of spreadsheets and the use of nested logical operators for complex comprehension as well as established statistical techniques.

The findings indicate that the degree of awareness of external environmental threats is associated with the degree of emphasis on the strategic planning process. The findings also show that strategic planning is positively linked to overall corporate performance.

Key words: strategy, planning, environment, performance
Introduction

Over the past two decades, academics, consultants and business practitioners have stressed the challenges facing business. Porter (1991:111) states ‘the starting point for the [dynamic] theory is that environmental change is relentless’. This statement encompasses the challenges facing most companies as they seek to grapple with change. D’Aveni (1994) sees intense and rapid competitive activity as ‘hypercompetition’. Another strategy guru, Peter Drucker (1999:ix) agrees and says that ‘we live in a period of profound transition’. Changing environmental conditions impact on most, if not all companies, leading to a greater emphasis on external environment, strategic direction and overall performance. Firms have already sought to address their internal environment by a series of continuous improvements to minimize operating costs. Rigby (2003) commenting on the Bain and Co, annual survey of business executives, states ‘surprisingly, given the pressure to control expenses, executive’s choice of tools shows a clear bias towards growth over cost cutting. The message is moving ahead, not retrenching…’

Gavetti et al (2005) suggests that strategy making is most critical in times of change and in unfamiliar environments. In a critical review of the strategic planning literature, Mintzberg (1994) comments that the ‘missing detail’ in the area is an understanding of how strategies are made. This echoes Capon et al (1990:1158) who conclude that the role of organizations in strategic planning is ‘badly in need of more work’. Accordingly, one would expect strategy making to be growing in importance in firms of all sizes. Research on strategic planning yields a mixed picture. Some findings stress the benefits of strategic planning in an increasingly turbulent and competitive business environment (Timmons et al, 1987; Robinson and Pearce, 1988; Armstrong, 1982). However, the literature suggests that the level of planning in smaller firms including HTSFs is low – Perry, (2001), Bhide, (1994), Robinson and Pearce (1984).

The awareness and understanding of the external operating environment is of the utmost importance to firms, to enable business leaders to align their firm’s strategies with external environment conditions – Bettis and Hitt (1995), Wholey and Brittain (1989). The importance of the external operating environment cannot be understated, and directly impacts on decision making processes as well as decisions taken – Eisenhardt (1989), Bogner & Barr (2000).

The paper is organized into five sections. Strategy, environment and performance constructs are discussed in the next three sections followed by a section on
methodology and data collection. Analysis using dynamic normative analysis (DNA) comes next followed by conclusions.

**Strategy**

Strategy is depicted as a set of beliefs on how a firm can achieve success – Wood and Joyce (2003). This is consistent with the contention that strategy involves significant intuition and philosophical thinking – Brockman and Anthony 2002, Beaver, (2003). However, it is much more than beliefs and encompasses ‘a deliberate search for a plan of action that will develop a business’s competitive advantage and compound it. For any company, the search is an iterative process...’ Henderson (1989:139). The iterative process includes predictions and forecasts on challenges and opportunities that the company is likely to encounter in the external environment. However, an iterative process assumes a rational process and approaching strategy in the ‘right way’ - Sauer and Willcocks (2003). But what is the right way? And is it possible to achieve consensus on a possible ‘right way’ given that there is no one right answer in business? Even if there were strong pointers to a possible right way, it is arguably difficult for CEOs and strategists to make decisions without reference to their own views on how strategy should be determined – Kotev and Meredith (1997), Hendry (2000), Frishammer (2003). In short, there are many competing ideals and multiple perspectives in business – Barney (2001), Priem and Butler (2001).

A review of the findings of previous studies suggests that the impact of strategy on overall performance is not as clear cut as one might expect. Several studies show a link between strategy and performance - Rue & Ibrahim, 1998; Bracker, Keats, & Pearson, 1988; Naffziger and Kuratko (1991), Lyles, Baird, Orris, & Kuratko, (1993). Several meta-analyses concluded that planning leads to greater financial returns – Robinson and Pearce (1984), Boyd (1991), Schwenk and Shrader (1993), Miller and Cardinal (1994). Other studies stress resultant benefits of strategic planning other than financial results, for example, reducing uncertainty (Matthews and Scott 1995), longer term focus with structured processes (Schwenk and Shrader 1993), an enhanced awareness of strategic options and direction (Lyles et al 1993). Arguably the quality of planning is also an important consideration.

Findings where strategy does not lead to any noticeably impact on smaller firms include O’Gorman and Doran (1999), McKiernan and Morris, 1994; Orpen, 1985; Robinson et al 1986, Gabel and Topol, 1987, Cragg and King, 1988; Shrader, Mulford and Blackburn, 1989; Watts and Ormsby, 1990). Nevertheless, based on the extant empirical literature, we can conclude that strategic planning has a largely positive impact on performance. This is consistent with the contention of Barry and Elmes (1997:430) that strategy must ‘rank as one of the most prominent, influential and
costly stories told in organizations'. It is therefore vital to the organization but is not without its attendant risks. In addition, the literature suggests that smaller firms such as growing HTSFs’ performance suffers due to ‘a lack of reference to strategy’ Hudson et al (2001).

This led us to derive the following research question:

‘Does strategy impact on the performance of manufacturing firms, and if so, to what extent’.

Following an extensive examination of the literature we adopted the following characteristics to represent the key factors used to craft strategy: external orientation, internal orientation, departmental or functional integration, staff creativity, employee involvement, the use of analytical techniques, resources for strategy (managerial and financial), and a focus on control. Their relevance was further examined through qualitative interviews with six managing directors of HTSFs.

Environment


Each aspect of change is subject to varying degrees of intensity. The literature contends that environmental dynamism drives the degree of emphasis on strategic planning – McLarney (2001). For example, Lang et al (1997) and Pineda et al (1988) state that when small to medium sized firms are confronted with a threat or opportunity, they tend to increase their search for information by scanning the external environment. However, it should be noted that this is a relatively recent trend in smaller firms [Lang et al., 1997; Smith, 1998], and runs parallel to their increasing attention to aspects of the strategic planning process. Indeed, it is arguably that small to medium sized firms have little choice but to engage in strategic planning, if they are to survive.

The greater use of information on the environment is consistent with the contention by Murray and Kotabe (2005), that firm’s strategy and environment need to interact in a dynamic co-alignment process. If effective alignment operates, then enhanced

Surprisingly, the literature presents a mixed picture on the impact of the environment on strategic planning. Grant (2003:494) encapsulates the extant literature by stating that ‘evidence of the impact of environmental turbulence upon strategic planning is limited. Cross-sectional studies have produced inconsistent findings. Longitudinal evidence is fragmented’.

We considered the extant literature as well as consulting with the Managing Directors of HTSFs to ascertain the aspects that describe the environment. While the environment as a concept is extremely broad and diverse (Sharfman and Dean, 1991), we followed the work of Miller (1988), by focusing on narrowly defined parts of the environment rather than on overall industry parameters. The reasons for this approach were twofold. First, managers select specific market segments for attention and second, they tend to identify a specific customer focus. These aspects can only be ascertained by examining managers’ perceptions - Dess and Beard, (1984). In any even, the literature suggest that perceived measures have strong associations with strategic planning as CEOs tend to act on their perceptions (Miller and Friesen, 1984), Collier et al (2004).

In our survey, we assessed three dimensions of the operating environment: turbulence, dynamism, and munificence. Turbulence is concerned with the unpredictability of environmental change, dynamism is concerned with the rate of foreseeable product, process, and regulatory change, and munificence is concerned with environments ability to support sustained growth of an organisation (Rasheed and Prescott, 1992). Munificence has three distinct dimensions: capacity, growth/decline and opportunity/threat (Castrogiovanni 1991). In this study, we focused on growth/decline and the threat elements of munificence by ascertaining the level of perceived threat from home, overseas, and substitute products. Past research on the impact of munificence on organisational strategies, structure, and process is limited (Goll and Rasheed, 1997)

This led us to formulate the following research question:

*Is there a link between the degree to which external environmental threats are taken into account during the strategic planning process and superior financial performance?*
Organizational Performance

Organizational performance management and control is increasingly seen by managers as a key activity – Langfield-Smith (1997). Performance ‘can be defined as the ability of an object to produce results in a dimension determined, a priori, in relation to a target’ - Laitinen (2002). This is consistent with the suggestion by Ittner and Larcker (2003) that performance measurement is used to allocate resources and map progress towards the achievement of strategic goals. This suggests that performance must be linked to actions emanating from strategic planning. To date, most studies tend to focus on financial related performance measures such as profitability. However, the trend is moving from reliance on financial orientated measures towards a stronger emphasis on a more comprehensive performance measurement system needs to comprise both financial and non-financial measures, intermittent and outcome measures – Dyson, (2000), Hillman and Keim (2001), McAdam and Bailie (2002). Laitinen (2002) encapsulates the increasing emphasis on broader performance measurement concepts by stating that ‘when financial and non-financial measures are incorporated in the same model, managers can survey performance in several areas simultaneously in order to enable efficient strategic decision making’. However, the literature contends that ‘to date, researchers have not reached consensus about many of the factors that may influence performance’ - Short et al (2002).

We conducted a range of exploratory interviews with MDs/CEOs and employer bodies on appropriate performance measures to the sectors under examination on the basis that a ‘multiple assessment’ of a firms performance using financial and non financial measures – Pett and Wolff (2003). The findings indicate that the following are important measures of performance: customer satisfaction, customer retention, market share, innovation, and long and short term measures. However, obtaining objective data from HTSFs is often very difficult. A number of scholars have advised caution when examining performance in privately owned or independent firms - Durand and Vargas (2003), Barney (2002), Schulze et al (2001). Garg et al (2003) pointed to the reluctance of CEOs/ MDs to provide detailed accounting data on their firm’s performance. The problem is more acute in the case of privately held HTSFs. Therefore, they suggest the use of ‘subjective, self-reporting measures of performance’. Measures such as overall perceived performance/success have been found to be highly correlated with objective measures of firm performance – Robinson and Pearce (1988), Venkatraman and Ramanujam (1987). Moreover the literature suggests that subjective measures should be used when interest centres on capturing the perspective of organization members - Boyd et al (1993). From a practical perspective, Jennings and Beaver (1997) contend that few small to medium
sized firms are able to find a balance between short term performance measures and longer-term growth orientated measures. However, financial measures are well used as the main measure of performance – Hammermesh et al (1978), Robinson (1983). Based on the work of Haleblian and Finkelstein (1993), we used a categorical approach based on ‘gross profit per FTE to assess the association between strategic planning and performance. Pett and Wolff (2003) suggest that this provides a multiple assessment of a firm’s performance. The literature suggests that non financial aspects of performance should also be measured. However there is a dearth of empirical studies using non financial measures particularly in HTSFs – Hudson et al (2001). Greenley (1994) suggests that the lack of studies relates to measurement inconsistencies.

Methodology

We used a self-reported postal survey to collect data for three reasons. First, to fulfill the objectives of the study we required a large number of observations in our data set. Second, the alternatives such as telephone survey and personal interviews were impractical because of the questionnaire’s size and the costs involved respectively. Previously empirically tested and validated constructs were used for strategic planning (Kargar and Parnell 1996), organizational performance (Kargar and Parnell 1996) and environmental turbulence (Jaworski and Kohli, 1993).

We used a staged approach to validate the questionnaire that included; an extensive literature review, in-depth interviews with six HTSF CEOs to ensure that issues raised were appropriate, and in-depth interviews with three employer representative organizations. Following these stages, a draft questionnaire was formulated and subsequently piloted. A number of adjustments were made following the pilot stage.

The initial sample of 1,000 randomly selected small and medium sized UK electronics and engineering firms was reduced to 702 firms as 198 firms did not meet the size criterion, had ceased operations, or were not contactable. The sample was based on the first two digits of the standard industrial classification (SIC) code because industry conditions influence the strategy-performance linkage. Questionnaires were targeted to the Chief Executives as they are perceived to be the most appropriate respondents for strategy research (Tan and Tan 2005), Bracker and Pearson (1986).
Others argue that CEOs tend to use the views and actions of other managers in the same sector as a reference point in the formulation of strategy – Fiegenbaum and Thomas (1995), Peteraf and Shanley (1997). Selecting the CEO as the self-reporting respondent is an established approach as they are seen as having a wide breadth of knowledge of all the organizations functions, activities and operating environment – Frost et al (2002). Avolio et al (1991 p. 571) state that the self reporting survey approach is ‘virtually indispensible in many research contexts’. We were careful to reduce or eliminate any contextual effects that might arise by basing the survey on pre selected sectors, extensive research and in depth interviews with practitioners and employer representative bodies as well as previously validated and tested constructs.

We received 194 valid responses - a response rate of 27 percent. This is a relatively high response rate as typical response rates for studies addressing strategic issues is 10-12 per cent (Geletkanycz, 1997). Contact prior to the dispatch of the questionnaire and follow up calls accounted for the high response rate.

A T-test was used to examine the difference between early and late informants’ response to key questions. This is an effective test for non-response bias because late respondents are likely to respond in a manner similar to non-respondents (Lambert and Harrington, 1990). We only found statistically significant differences at 10 per cent confidence level in the case of couple of questions. Based on this test and telephone contact with non-respondents, we conclude that non-response is not a significant issue and should not affect our conclusions. Data reliability was confirmed using Cronbach’s alpha – a commonly used statistical tool to consider data reliability when perceptual measures are used – Hambrick (1982).

Analysis

The literature suggests that many of the commonly used models and statistical techniques are not readily accessible or understood by practitioners and consequently fail to bridge the gap between theory and practice Chiles (2003), Hambrick (1990:251). These include cognitive mapping Laukkanen, 1996: 28), Forbes, 1999), complexity theory Tsoukas & Chia, 2002), process theory Chiles (2003), and a range of statistical techniques. From a practitioner perspective, we can conclude from the low usage rates of existing developed techniques by HTSF managers, that a more practical approach is needed. Arguably, the relative ‘newness’ of the field of management strategy research might be a reason why HTSF practitioners are slow to adopt some tools and techniques. In addition, practitioners may be daunted by the range and complexity of existing initiatives,
tools and techniques. Accordingly, we contend that a practical analytical tool is essential for deployment by HTSFs as they grow and strive to achieve competitive advantage. We have developed and tested an easily understood and useable method based on conditionally formatted spreadsheets to produce a visual picture of the attribute/s under consideration. Such an approach complements current research techniques and enables HTSF managers and academics to obtain a preliminary view of data based on the use of ‘attribute footprints’. Each footprint calculation encompasses three or more numerically scored responses to questions. In order to overcome the difficulties associated with responses where different scales are used, we developed ‘attribute footprints’ for strategy, the operating environment and performance as described in the following paragraphs.

**Strategy footprint**

The strategy footprint is designed to capture those companies with activities that are commonly used to shape strategic planning but do not consider themselves to have a formalized strategic planning function. Furthermore, we also include in the strategy footprint firms with a formal planning process.

The first part of the footprint calculation involves four 'non strategically labeled' questions from various parts of the questionnaire and which were responded to by the participants in terms of a 1 to 5 scale where 5 is considered to be very important and 1 not important. So, for example, if a respondent perceived that "formal policies guide most decisions", was very important then they would circle the 5. They might score the question about capital expenditures with a '4' and say a '3' for the question as to the formality of plans and a '3' for formal budgets. The resultant calculation for this part of the footprint would be;

\[
(5*4/2)+(4*3/2)+(3*3/2) = 20.5, \text{ ie the area contained within the three right angled triangles illustrated in figure 1.}
\]
Figure 1 Illustration of the initial elements of a strategy footprint

The areas of each of the three right angled triangles that make up this part of the footprint are calculated and then added together. The maximum possible score from this part of the footprint would be 37.5 \([(5*5/2)+(5*5/2)+(5*5/2) = 37.5]) while the minimum would be 1.5 \((1*1/2)+(1*1/2)+(1*1/2) = 1.5\).

Chief Executives were asked if they had developed a written strategic plan. If the respondents answer yes, then 50 is added to their footprint score. This has the effect of providing a step in the ranked strategy footprint scores enabling the authors to differentiate between 'non planners', 'planners' and 'strategic planners'.

The degree of strategic planning is assessed by counting the number of responses to the following questions [responses were yes/no]:

- Did you consider the strategic planning future horizon?
- Did you specify goals and objectives?
- Did you consider alternative strategies?
- Did you develop plans for functional areas?
Did you consider future resources required?  
Have you procedures for anticipating, detecting errors in, or failures of the plan and for preventing or correcting them on a continuing basis?

The number of positive responses was totaled and multiplied by 10 in order to weight the responses from the very important strategy questions. If the respondent had indicated a maximum for each of the initial questions in the first part of the footprint AND had said 'yes' to each of the questions on strategy, then that companies strategy footprint would be calculated thus:

\[
(5\times\frac{5}{2})+(5\times\frac{5}{2})+(5\times\frac{5}{2}) + 50 + ((6\times\frac{5}{2})\times10) + ((6\times\frac{5}{2})\times10) = 387.5
\]

and the 'best possible' strategy footprint score is shown in figure 2

**Figure 2 Depiction of largest strategy footprint.**

The resultant possible footprint score ranged from 1.5 to 387 which was sufficiently sensitive to enable the authors to differentiate between 200 or so different firms and their propensity to plan strategically when the sample was ranked in terms of strategic footprint score.
Environmental footprint

The environmental footprint consists of the simple addition of scores to 6 responses on a 1 to 5 scale all concerning real or perceived threats from the external operating environment to the companies. A score of 5 in each of the questions means that the respondent strongly agrees that the firm recognized and was affected by the described threat and a score of 1 indicates that the firm did not recognize the threat and/or was unaffected by the threat over the previous three years.

A total footprint score of 6 says that the firm strongly disagrees with the notion that the environment was turbulent and that it was subject to a threat from substitute products entering the market place. It also means that it strongly disagrees with the idea that new firms entered the market and that there was no threat from overseas. It also denied any threat from a decreasing product life cycle and disagreed with the idea that there was more red tape. The footprint therefore is a measure of environmental indifference or non awareness/non recognition at one end of the scale (we have chosen to call these firms 'loungers'), and a measure of a firms general environmental awareness at the other (leaders).

Figure 3 Environmental awareness continuum

![Environmental awareness continuum]

6
Environmentally optimistic
(no threat and or no action ie "Loungers")
30
Environmentally pessimistic
(threat recognition and planning action ie Leaders)

A score of 30 strongly agrees that all the above threats were perceived during the previous three years. Our footprint responses ranged from 6 to 30. Our hypothesis is that if firms recognize risk and plan strategically, they will do better than firms who don’t recognize or choose to ignore the external threats and don’t plan accordingly.

Company Financial Performance Measure

Companies responded to questions regarding turnover, the number of FTEs and gross profit margin. Thus we were able to establish the gross profit /annum/ FTE as a financially based performance measure by taking the company turnover and
multiplying it by the gross profit margin and dividing the result by the number of full time employees.

**Analysis using a DNA Methodology**

Dynamic Normative Analysis (DNA) involves the use of data located in a spreadsheet. Each of the spreadsheet cells usually contains a number representing a response to a given question. Most conventional methods used for the subsequent analysis of this data usually involve statistical manipulation/interpretation resulting in output in the form of more numbers or graphs. However, the authors suggest that the majority of people who make up the audience interested in any statistically based report might be helped by the inclusion of a 'picture' of the information being described rather than a picture of the statistical results.

The pictures are made up from cells in a spreadsheet that highlight an attribute value of interest. The steps that need to be taken in creating a 'data picture' are comparatively simple. The first and perhaps most important step is to rank the data in terms of the 'investigative focus' of interest to the researcher. (in this paper the authors have ranked the database in terms of a calculated 'strategy footprint'). The second step is to conditionally format the ranked data in terms of a 'trigger' or 'highlight default' cell. This cell requires an input value from the user and can be changed by the user. In order to create the different data pictures, the researcher simply has to change the highlight default cell value thus ensuring that the DNA analysis is 'dynamic'.

In order to 'see the whole picture', a third step might be to reduce the spreadsheet row height to a fraction of the standard default setting of say 12. (in order to create a picture with 200 rows on a single piece of paper, a row height setting of 2 is recommended). The final step is to combine the first set of ranked, formatted data with other similarly ranked and formatted data so that two or more variables can be viewed simultaneously and different pictures painted in a dynamic environment by changing the values in the highlight default cells.
Strategy / Performance

Figure 4 shows a column where all the company’s are ranked in terms of their strategy footprint score from the worst score (1.5) at the top of the column to the highest score (387) at the bottom of the column. The lowest and highest quartiles of 'strategists' are highlighted along with the point on the continuum that formal strategic thinking starts.

Figure 4  Firms Rank by emphasis on Strategy

If we now include data for each company's financial performance and set a 'highlighting default' to >=£50,000, the companies whose gross profit per annum per FTE is equal to or greater than £50,000 are highlighted in figure 5.
If the 'highlighting default' is now changed to reveal the patterns associated with a range of different performances, the patterns illustrated in figure 6 result.

It can see that there is a distinct clustering in the leader quartile of the strategy footprint continuum and an even greater clustering by companies with the greatest focus on strategic planning and **all** the companies highlighted involve themselves in some degree of formalized planning.
The analysis of the patterns in figure 6 can be summarized in the form of table 1 and it can be seen that high or very high company performance is most often associated with firms who involve themselves in a high degree of strategic planning.
Table 1  The proportions of each financial performance cohort associated with the various strategic planning quartiles

<table>
<thead>
<tr>
<th></th>
<th>&gt;=£60000</th>
<th>&gt;=£50000</th>
<th>&gt;=£40000</th>
<th>&gt;=£30000</th>
<th>&gt;=£20000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest planning Performance quartile</td>
<td>0</td>
<td>14%</td>
<td>22%</td>
<td>20%</td>
<td>21%</td>
</tr>
<tr>
<td>Middle planning Performance quartiles</td>
<td>33%</td>
<td>36%</td>
<td>43%</td>
<td>48%</td>
<td>49%</td>
</tr>
<tr>
<td>Highest planning Performance quartile</td>
<td>67%</td>
<td>50%</td>
<td>35%</td>
<td>32%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Two thirds of the highest financial performers are to be found in the highest planning quartile with none of the financial 'high flyers' being found in the area where little or no planning takes place.

As the financial performance hurdle is lowered, so the percentage of firms to be found in the lowest 'planning quartile' increases. It can be seen that, even at the lowest level of financial performance, strategic planning has a high profile.

To enable a closer look at the 'lowest financial performers', the conditional formatting of the financial performance range of cells was adjusted to highlight those firms whose financial performance is less than 'X'. So with the highlighting default set at a range of low values, figure 7 emerges.
The analysis of the DNA output from figure 7 is depicted in descriptive format in table 2.
Table 2  The proportions of each financial performance cohort associated with the various strategic planning quartiles

<table>
<thead>
<tr>
<th></th>
<th>&lt;=£0</th>
<th>&lt;=£750</th>
<th>&lt;=7000</th>
<th>&lt;=10000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest planning Performance quartile</td>
<td>38%</td>
<td>50%</td>
<td>34%</td>
<td>33%</td>
</tr>
<tr>
<td>Middle planning Performance quartiles</td>
<td>62%</td>
<td>50%</td>
<td>54%</td>
<td>53%</td>
</tr>
<tr>
<td>Highest planning Performance quartile</td>
<td>0%</td>
<td>0%</td>
<td>12%</td>
<td>14%</td>
</tr>
</tbody>
</table>

The results illustrated in figure 7 and reported in table 2 suggest that poor company performance, ie annual gross profit per employee of less than £10,000 is associated with the lower end of the strategic planning spectrum.

With performance set at >=£36000 we capture the highest performing quartile of companies – 39 in total. Of the upper quartile of financial performers, 10 are in the lowest strategy footprint quartile and 14 are in the highest strategy quartile.

Figure 8  Location of upper quartile of financial performers

Sixty four percent of the upper quartile of financial performers involve themselves in formal strategic planning.
If the financial default is set to highlight firms who make between £56000 and £90000 gross profit per employee per year, figure 9 results;

Figure 9  Location of the top 3% of financial performers on the strategy continuum

Also note that all those companies making between £56000 and £90000 gross profit per FTE involve themselves in

Given the relative positions of the high and low performers on the strategic planning continuum illustrated in figures 6, 7, 8 and 9 and summarized in tables 1 and 2, we can conclude that the degree to which a company indulges in the planning process will impact positively on their financial performance. Thus saying yes to the first research question 'Does strategy impact on the performance of manufacturing firms, and if so, to what extent'. However the 'extent' of the impact has yet to be quantified.
Environmental Threat / Performance

Maintaining our firms ranked in terms of their strategy footprint, consideration was given to the degree of 'environmental threat recognition' by the respondent companies. With the left hand column 'highlighting default' set at <=10 and the right hand column set at >=20, the two ends of the environmental threat recognition spectrum are highlighted in figure 10. In figure 3, we labeled firms at the extremities of the environmental threat continuum 'Leaders' and 'Loungers'.

Figure 10  Relative positions on the strategy continuum of the environmental loungers and leaders.

Of the 10 companies who were either unaware of or failed to recognize or were not subject to any external environmental threat, 8 (80%) did not engage in strategic planning.

Twenty six percent of the environmentally reactive upper quartile companies were in the lower strategy quartile. Sixty five percent of the same cohort were active strategists with 32% being highly active strategically, ie in the upper quartile of strategic planners.
Figure 11 illustrates the position of the 23 companies with an environmental score of less than 12. Eleven (48%) found themselves to be in the lowest strategy quartile and only three (13%) in the upper strategy quartile.

Figure 11  Location of some more environmental loungers on the strategy continuum
Environmental threat / Strategy / Performance

In order to capture the lowest quartile of environmental loungers, the 'highlight default' value was adjusted to $<15$ and to $>20$ in order to capture our environmentally aware leaders. The results of this adjustment are shown in figure 12.

**Figure 12** Location of the lower quartile of environmental loungers and the upper quartile of environmental leaders.

With the 'less than or equal to ' environmental footprint trigger set at 15, the 'lowest environmentally aware / active' quartile are illustrated. Almost half (44%) do not involve themselves in any formal strategic planning and the average gross profit per FTE in the lower planning quartile was £17826 which rose to £25562 in the upper planning quartile.
To capture the more environmentally aware/responsive quartile (in this case 48 firms) set 'more than' trigger at 20. With trigger set at >20, 16 companies (33%), are found in the upper planning quartile with an average gross profit per FTE of £23898. Thirteen firms companies (26%) are to be found in the lower planning quartile with an average profit of £15174.

Table 3 locates summarizes an analysis of figure 12.

Table 3 Average financial performance [Gross profit /FTE] of Leaders and Loungers

<table>
<thead>
<tr>
<th></th>
<th>Highly environmentally aware (leaders)</th>
<th>Low environmental Impact / Care /Awareness (loungers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower strategic quartile</td>
<td>£15174</td>
<td>£17826</td>
</tr>
<tr>
<td>Upper strategic quartile</td>
<td>£23898</td>
<td>£25562</td>
</tr>
</tbody>
</table>

It can be seen that, amongst both the leaders and the loungers, financial performance increases significantly with the degree of planning undertaken. This finding leads us to conclude that ‘there a link between the degree to which external environmental threats are taken into account during the strategic planning process and superior financial performance’.

Conclusions and recommendations

The development and application of 'attribute footprints' has been shown to be a useful tool for the analysis of company characteristics. When used as a ranked listing and with the ability to adjust the 'highlight default' setting, the user may experiment with the data and extract trends or patterns which may not otherwise be immediately obvious or visible. The major advantage of the research methodology described is its 'accessibility'. Spreadsheets in business are almost as common as pen and paper but are very rarely used to their full potential. The authors are suggesting that, with comparatively little effort, companies can start to analyze their own data in a meaningful way without having to rely on expensive, sometimes time consuming and sophisticated statistical packages. The Data Mining method explored in this paper, enables a firm to deal with large or small amounts of data in an accurate efficient manner.
The results of our investigations have shown that strategic planning impacts positively on financial performance and that where an environmental threat exists, that the threat should be recognized and taken into account during the planning process. It is interesting to note that, where the external environment is of little or no consequence to a company's operations, the average performance (gross profit per FTE) is significantly higher for both the planners (upper quartile) and the non-planners (lower quartile).

The lower average performance on the part of the 'highly environmentally aware' firms in both the lower and upper planning quartiles may be a consequence of the dampening effect of the external environment on a firm's performance. However it is interesting to note the positive effect of strategic planning. Among the 'highly environmentally aware' there is a 57% difference between the high and low planners compared to a 43% difference in the 'non environmentally aware' group. The effect therefore of strategic planning is to significantly reduce the effect of any external environmental threat illustrated in table 4 (below) by the closing of the performance gap by the upper quartile strategic planners.

Table 4  
An indication of the extent to which strategic planning closes the performance gap

<table>
<thead>
<tr>
<th></th>
<th>Highly environmentally aware</th>
<th>Low environmental Impact / Care /Awareness</th>
</tr>
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<tbody>
<tr>
<td><strong>Lower strategic profile</strong></td>
<td>£15174 17.5% diff</td>
<td>£17826</td>
</tr>
<tr>
<td><strong>Upper strategic Profile</strong></td>
<td>£23898 7% diff</td>
<td>£25562</td>
</tr>
</tbody>
</table>

57% difference between high and low strategists where environment matters

Therefore strategic planning closes the performance gap from 17.5% to 7%.

43% difference between planning regimes where environment less of an issue.
Summary and Conclusions

The results of this study aims to help practicing managers by emphasizing the need to focus on strategic planning and ensure alignment with the external environment. The research findings fill a gap in the strategic management literature by clarifying the strategy-performance relationship – an issue where the consensus of previous research is unclear.

We approached the study by developing a series of footprints for strategic planning and the environment. This is an approach not hitherto used extensively in the case of manufacturing HTSFs. We identified firms as ‘planners’, non-planners’ or ‘strategic planners’. In the case of ‘strategic planners’, we identified the degree of emphasis on strategic planning having regard to the extent that they used formal policies and procedures guide most decisions, planned capital expenditure well in advance, used formal and written plans, and used formal operating budgets to guide day to day decision making. In the case of the environment we used a range of measures to determine if a firm is environmentally optimistic (where the environment is perceived to be of little threat or concern) or environmentally pessimistic (where environmental threats are recognized and actions taken).

The findings indicate that the degree of awareness of external environmental threats is associated with the degree of emphasis on the strategic planning process. The findings also show that strategic planning is positively linked to overall corporate performance. In line with the mainstream position within the literature, the external environment had a significant impact on relationship between strategic planning and performance.

Our study redresses a number of limitations associated with prior studies. We adopted a new approach to multi-variate analysis based on the conditional formatting of spreadsheets and the use of nested logical operators. Moreover, we also took care to ensure that our constructs were grounded in theory increasing their validity.

There are also a number of limitations of this study. The variety and number of strategy making process variables means that any single investigation of this relationship is unlikely to be exhaustive. In this study, we focus on identifying strategy footprints underpinned by a limited range of variables.
From a practical point of view our study suggests that increased strategic focus improves performance, but without longitudinal objective measures we can not quantify the size of benefit. To increase the intensity of focus a manager needs to know not only that it is beneficial, but also the potential magnitude of the benefit. Augmenting the subjective measures with temporal objectives measures would have strengthened the study by providing an answer to this question as well as providing additional support for the use of subjective measures.

Only small manufacturing firms were surveyed. Therefore, the generalizability of the results to other industries, or firms of larger size, must await future research. Moreover, we only established whether the level of emphasis on strategic planning is related to performance. We recognize that many organizational factors affect performance and as a result cause and effect relationships are extremely difficult to establish. Having shown that strategic planning has a direct affect on company performance we are left with the question as to why our loungers consistently out performed our leaders. One explanation might be that a significant proportion of ‘loungers’ might have lesser need to consider the external environment. Another limitation relates to the degree of product differentiation among loungers. Future research directions should seek to quantify the extent of the impact of strategic planning and to identify a possible third group, ie loungers who are at risk but who do nothing about their situation (we could call them laggards) as well as a sector analysis.

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A conceptual framework for studying a technology transfer from academia to new firms

Igor Prodan
Regional Technological Centre Zasavje
Grajska pot 10, 1430 Hrastnik, SI – Slovenia
igor.prodan@guest.arnes.si

prof. dr. Mateja Drnovsek
Faculty of Economics, University of Ljubljana
Kardeljeva ploscad 17, 1000 Ljubljana, SI - Slovenia
mateja.drnovsek@ef.uni-lj.si

prof. dr. Jan Ulijn
Faculty of Technology Management, Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven, The Netherlands
J.M.Ulijn@tm.tue.nl
Abstract
This paper summarizes results of an ongoing research of determinants of technology transfer from academia to new firms. Drawing from previous theoretical and empirical developments in the literature, a conceptual framework for studying technology transfer at the individual’s level (entrepreneur’s standpoint) is developed. The elements of the conceptual framework at the individual’s level are (1) as dependent variables: Academic’s entrepreneurial involvement or Academic’s intention to become an entrepreneur and (2) as independent variables: Personal networks, Number of years spent at the academic institution, Nature of research, Motivational factors, Previous work with the industry, Scientific publications, Role models, Support from academic institution, Patents and Entrepreneurial self efficacy.

We believe that the proposed conceptual framework for studying technology transfer from academia to new firms will help researchers, policy makers and practitioners in designing policy measures and instruments to foster technology transfer from academia to new firms. In further stages of this research the model will be tested in three European regions (Slovenia, Eindhoven area and Cambridge area) for intercultural comparison.

1. Introduction
Global technological competition has made technology transfer from academia to firms an important public policy issue (Rahm 1994). Academia and individual academic institutions are a primary source of new knowledge production and innovation (Brennan and Pauric 2006 forthcoming). It is widely acknowledged that the commercialization of scientific and technological knowledge produced in public funded research institutions, including universities and research centres, to the marketplace have a fundamental role to play in wealth creation, supports economic growth and technological innovation, and plays a significant role in new venture creation, growth of existing firms and new job creation (Mansfield 1991, Harmon et al. 1997, Ndonzuau et al. 2002, Siegel et al. 2003b). Research by Acs et al. (1992), Jaffe (1989), Mansfield (1991, 1998) and others indicate that technological change in important segments of the economy has been based significant on knowledge that spun from academic research.

Academic spin-offs are an important means of technology transfer from an academic organization, an important mechanism for economic activity (Gregorio and Shane 2003, Roberts and Malone 1996, Nicolaou and Birley 2003a), a mechanism for creating jobs and new wealth (Steffensen et al. 1999, Walter et al. in press, Perez and Sanchez 2003), are being a key dimension in industry science links (Debackere and Veugelers 2005), are important means of regions’ economic development (Mian 1997, Nicolaou and Birley 2003a) and are an important mechanism for introducing new commercial products to the marketplace (Association of University Technology Managers 2002). For example, spin-offs are the main mechanism for the rapid growth of technopolises like Silicon Valey, Route 128, Austin, Cambridge and others (Rogers et al. 2001). Carayannis et al. (1998) quote a Bank of Boston survey (1997) which observed that Massachusetts Institute of Technology had spun-off approximately 4,000 companies, employing 1.1 million people and generating an annual worldwide sale of 232 billion US dollars. Furthermore Mustar (1997) reported that 200 academic spin-off from France that he has studied, created 3500 jobs. Spin-offs are also found as a mechanism for emerging new industries in the long run (Roberts 1991).

Although many start-ups may fail within a few years as the technology itself fails to prove viable and financiers pull out, on occasion university based start-ups may grow into major industrial contenders. Several major employers in the San Francisco Bay area that were
spawned from university include Sun Microsystems, Cisco Systems, Chiron and Genentec. Most often, the results is somewhere in the middle: successful start-ups based on university technologies are acquired and absorbed by larger companies who seek out the technology or expertise developed by a start-up to complement their own R&D initiatives (Graft et al. 2002).

Politicians in European Union also recognized the importance of technology transfer from academia and establishment of spin-offs, therefore European Union funds projects such as PROTON (pan-European network of Technology Transfer Offices and companies affiliated to universities and other Public Research Organisations), PRIME (Policies for Research and Innovation in the Move towards the European Research Area) and INDICOM (Direct indicators for commercialisation of research and technology) that are examining issues concerning technology transfer from academia and establishment of academic spin-offs (Lockett et al. 2005).

Policymakers in many developed countries have responded to importance of academic spin-offs also by erecting infrastructures intended to facilitate the commercialization of scientific research output (Goldfarb and Henrekson 2003). For example, to stimulate the commercialization of university-based research and promote spin-offs, the UK government established the £50 million “University Challenge” which provides venture capital funding for university based spin-offs and based on a project “Science Enterprise Challenge” created 12 Government sponsored science enterprise centres at several UK universities which provide educational, training and financial services to would-be academic and graduate entrepreneurs (Wright et al. 2004, Lockett et al. 2005).

The aims of this theoretical and construct conceptualization paper are two fold: (a) to provide a discipline appropriate conceptualization of the constructs relevant for studying technology transfer processes, and (b) to develop an empirically testable model a technology transfer from academia to new firms.

2. Technology Transfer Process: Construct Conceptualizations
To avoid confusion resulting from various definitions of technology transfer and academic spin-off companies found in previous literature, it is necessary to know how we define these two terms in our research.

2.1 Technology transfer
Technology is information that is put into use in order to accomplish some task (Carayannis et al. 1998).

There is no widely accepted definition of technology transfer, but, generally speaking, technology transfer is the sharing of technology, technique or knowledge (Melkers et al. 1993, cited in Phillips 2002) and also know-how and organizational rationalities, which are the “soft” dimensions of technology (Storper 1995) among: individuals, industry, universities, public research institutions, federal, state and local governments and third party intermediaries. Walsh and Kirchhoff (2002) explained that some form of technology transfer occurs in all organizations among and between departments in the organization, between manufactures and vendors, and between manufacturers and their customers. Walsh and Kirchhoff (2002) additionally explained that any technology transfer model developed in the environment of conflicting objectives (which is based on the need for secrecy) must include a high degree of interaction and communication as a necessary ingredient. This is especially
true for disruptive technologies since the high level of uncertainty attached to new-to-the-world technologies requires trials in many different industries and many different products. There are several more narrowly definitions of technology transfer. For example Phillips (2002) for the purpose of research on technology business incubators, defined technology transfer as the licensing of technology from a university to an incubator client firm, Powers and McDougall (2005) defined university technology transfer as a process of transforming university research into marketable products etc.

Bozeman (2000) defined eight different transfer media or communication channels for technology transfer process: Literature, Patent, License, Absorption, Informal, Personnel Exchange, On-site Demonstration and Spin-off.

In this research technology transfer is defined as a transfer of knowledge, scientific or technical know-how, technology, technology-based ideas or research results, developed within an academic institution, from academic institution to industry, where an academic institution may or may not have the property rights for commercialization of such scientific or technical know-how, technology or research results.

2.2. Spin-off
There have been number of studies of spin-offs worldwide and various definitions are applicable. In one of the first studies on spin-offs Cooper (1971) used a term spin-off for a new company independent from parent organization which is often started by a group of founders from the same parent company. According to Cooper (1971) a spin-off company is technological based and emphasizes research and development or places major emphasise on exploiting new technical knowledge.

Garvin (1983) proposed that spin-offs are new firms created by individuals breaking off from existing ones to create compositing companies of their own. A spin-off normally occurs when a firm is formed by individuals leaving an existing firm in the same industry.

Smilor et al. (1990) defined university spin-off as a company that is founded (1) by a faculty member, staff member, or students who left the university to start a company or who started the company while still affiliated with the university; and/or (2) around a technology or technology-based idea developed within the university. Similar to this definition is a definition of Steffensen et al. (1999): a spin-off is a new company that is formed (1) by individuals who were former employees of a parent organization, and (2) around a core technology that is transferred from the parent organization. Another similar but different is a definition of spin-off from Nicolaou and Birley (2003a) which proposed a definition of university spin-offs as a company which involve (1) the transfer of a core technology from an academic institution into a new company and (2) the founding member(s) may include the inventor academic(s) who may or may not be currently affiliated with the academic institution. They additionally explicitly excluded companies established by current or former members of a university which do not involve the commercialization of intellectual property arising from academic research.

Carayannis et al. (1998) first defined a spin-off as a new company formed by individuals who were former employees of a parent organization, around a core technology that originated at a parent organization and that was transferred to the new company. In conclusions of their research they suggested that it is an oversimplification to define a spin-off as a new company
in which both the founder and the core technology are transferred from a parent organization, since only one or the other or both of these factors may be transferred.

Walter et al. (in press) defined an academic spin-off as business ventures that are founded by one or more academics who choose to work in the private sector (at least part-time) and that transfer a core technology from the parent organization.

Weatherston (1995) described the academic started venture or spin-off as a business venture which was initiated, or became commercially active, with the academic entrepreneur playing a key role in any or all of the planning, initial establishment, or subsequent management phases.

Rappert et al. (1999) in their research on academic–industrial relations and intellectual property defined university spin-offs as companies whose products or services develop out of technology-based ideas or scientific/technical know-how generated in a university setting by a member of faculty, staff or student who founded (or co-founded with others) the firm. The individual or individuals may either leave the university to start a company or start the company while still inside the university. It does not matter whether someone was a student or full-time academic and the time interval between the initial research and commercial exploitation is not an issue so long as their university research experience was essential in enabling the firm to provide particular products or services (rather than, for instance, the university experience merely providing background knowledge).

Pirnay et al. (2003) based on literature review proposed a definition of a university spin-off as a new firm created to exploit commercially some knowledge, technology or research results developed within a university. Similarity, but narrowly Druilhe and Garnsey (2004) defined spin-off as a new firm commercializing a proprietary leading-edge technology from a university department and backed by venture capital.

Grandi and Grimaldi (2005) proposed a generic definition of university spin-off, which includes cases in which university dependents (academic founders) start a company on the basis of either a university-assigned technology (license on a patented technology) or a more generic area of technological knowledge (non-university-assigned). They proposed, that a university spin-off also encompasses situations in which the university elects to provide the rights to the technology to an external, independent entrepreneur, non-university-dependent (non-academic founder), who initiates a new company.

Lockett and Wright (2005) narrowly defined university spin-offs as new ventures that are dependent upon licensing or assignment of the institution’s intellectual property for initiation.

To avoid confusion resulting from various definitions of academic spin-off companies found in previous literature, it is necessary to define what we mean by an academic spin-off company in this research. We define an academic spin-off as a company that (1) is founded (or co-founded by non-academics) by one or more academics (not including students), (2) was created to exploit commercially some knowledge, scientific or technical know-how, technology, technology-based ideas or research results developed within an academic institution, (3) where an academic institution may or may not have the property rights for commercialization of such scientific or technical know-how, technology or research results and (4) where it is not necessary that such knowledge, scientific or technical know-how,
technology, technology-based ideas or research results developed within an academic institution is a core research focus of an academic institution.

3. Technology transfer from academia to industry
It is clear that there is more than one mechanism to the commercialization of academic intellectual property. Key mechanisms are formation of spin-off companies, patents, licenses and research join-ventures (Lockett et al. 2005). Since Jensen and Thursby (2001) found that only 12% of university inventions were ready for commercial use at a time of licence (which points to the importance of incubation (Clarysse et al. 2005)) and manufacturing feasibility was known for only 8% and similarly Jensen et al. (2003) reported, that faculty involvement in further development is necessary for commercial success for 71% of the inventions licensed, we can be positive that whatever the route of technology transfer is, core to its success will be the role played by the creator of the intellectual property, the individual scientist or engineer (Jensen and Thursby 2001, Jensen et al. 2003, Goldfarb and Henrekson 2003, Wright et al. 2004, Markman et al. 2005b). Also, although an innovation may seem clearly applicable or marketable, it is common, that still no existing firm will risk taking on it (Graft et al. 2002), thus academic spin-offs are important mechanism for transferring technology from academia since the scientist is actively involved in its creation. In addition, spin-offs based on university technology (such as Lycos, Genentech, Cirrus Logic) tend to survive longer and are more likely to achieve Initial Public Offering (IPO) status (Shane and Stuart 2002).

Where in the past academic institutions have passively licensed their technologies to large established companies (Siegel et al. 2003a) today many academic institution actively search ways to channel proprietary technology to maximize rents to spawn new companies (Thursby et al. 2001, Wright et al. 2004, Chapple et al. 2005, Powers and McDougall 2005). Licensing, which is the most common mechanism to commercialize university technology (Radosevich 1995), has the advantage that the academic and the university are able to capitalize on the technology, and the academic is able to pursue his/her research without having to commit large amount of time to commercial matters (Lockett and Wright 2005). The downsides to this approach are (Franklin et al. 2001):

- the nature of the new technology may not be easily patented and transacted via a license agreement and,
- universities may not be able to capture the full value of their technology through a licensing agreement and therefore seek a more direct involvement in the commercialization of new technology through spin-off companies.

Despite the perceived importance of spin-offs and growth in the number of spin-offs from universities, there have been very few systematic studies that have examined this phenomenon. In fact, in most research, spin-offs have been one of a number of technology transfer mechanisms under study, including patenting and licensing with relatively little emphasis placed on detailed research into spin-off activity per se (Leitch and Harrison 2005).

4. A conceptual framework for studying a technology transfer process
Academic entrepreneurship arises from internal as well as external impetuses (Etzkowitz 2003). Both micro and macro level factors influence the decision to create a new company to exploit an academic invention. At the micro level, research has shown that motivational factors of academics’ (Roberts 1991, Steffensen et al. 1999, Shane 2004b), the attributes of technological inventions themselves (Shane 2001a), inventors’ career experience (Levin and Stephan 1991), their psychological make-up (Roberts 1991) and their research skills (Zucker
et al. 1998) influence this decision. At the macro level, research has shown that technology regimes and characteristics of parent organization (Shane 2001b, Rogers et al. 2001, Powers and McDougall 2005), size of technology transfer office (O’Shea et al. 2005), age of technology transfer office (Roberts and Malone 1996, Powers and McDougall 2005) size of federal funding in science and engineering (Shane 2004b, Powers and McDougall 2005), level of industry R&D funding (Powers and McDougall 2005), availability of venture capital (Druilhe and Garnsey 2004, Powers and McDougall 2005) the strength of patent protection in a line of business (Shane 2002b), spin-off/parent conflict (Steffensen et al. 1999), the university rewards system, which is based mainly on publications and citations (Goldfarb and Henrekson 2003, Franklin et al. 2001) university quality (O’Shea et al. 2005), universities’ intellectual property (Goldfarb et al. 2001), official university policy towards spin-offs (Chiesa and Piccaluga 1998, Roberts and Malone 1996) and government policies (Liu and Jiang 2001, Shane 2004b) influence this decision.

Although both micro and macro level factors influence the tendency of academics to start a new company to exploit academic inventions, we discuss only factors from entrepreneur’s standpoint in this research. In developing the conceptual model of technology transfer from academia to new firms (Figure 1) we included the key facilitators as well as the key barriers to technology transfer previously identified in the literature (mainly literature about general entrepreneurship, about psychology of entrepreneurs, technology transfer, academic entrepreneurship and university-industry links) and also some additional facilitators as well as barriers to technology transfer, we identified during previous research. These factors that influence Academic’s entrepreneurial involvement or Academic’s intention to become an entrepreneur are: Personal networks, Number of years spent at the academic institution, Nature of research, Motivational factors, Previous work with the industry, Scientific publications, Role models, Support from academic institution, Patents and Entrepreneurial self efficacy.

![Figure 1: Conceptual framework for studying technology transfer from academia to new firms from the academic’s / academic’s entrepreneur point of view](Image)

Source: Authors development.
In what follows we in detail explain the conceptual model, together with both dependent variables and individual factors that influence Academic’s entrepreneurial involvement or Academic’s intention to become an entrepreneur. We also added measurement instruments for each variable.

4.1 Dependent variables

**Academic’s entrepreneurial involvement**

The academic entrepreneur need to make choices in terms of committing full time to a spin-off or academic institution or working part-time at both. On the one hand, the academic may leave the academia to completely focus his or her energy in the firm; on the other hand, the inventor may decide to remain in the academia and may or may not accept a part time position in the company (Nicolaou and Birley 2003b). Harmon et al. (1997) found that few university inventors leave the university but rather generally help to commercialize the invention on a part-time basis. When academics establish a spin-off company this does not necessarily imply that they leave their academic position permanently, nor take a leave of absence (Goldfarb and Henrekson 2003). Richter (1986) estimated that 3.3 percent of scientists and engineers who are employed full time as professors in American four-year higher educational institutions also work as consultants for commercial companies of which they are owners or part owners. Similarly, Allen and Norling (1991) found out that among 912 faculty members in science, engineering, business and medicine 16.2 percent of academics are engaged in firm formation, but only 4.4 percent is engaged in firm formation on the basis of their academic research.

Most scholars have (1) tried to identify differences between entrepreneurs (academic entrepreneurs) and non-entrepreneurs (academics) for which they used dichotomous variable which coded entrepreneurs as 1 and non-entrepreneurs as 0 or (2) tried to determine a typology of academic entrepreneurs. Since academic entrepreneurs are specific and since there are clearly differences among those who have establish a spin-off we propose a new variable, called Academic’s entrepreneurial involvement which measures the involvement of academic in his or her spin-off company. To our knowledge, so far there has been no scale variable that measured academic’s entrepreneurial involvement.

This type of dependent variable can then be used in regression models as dependent variable and also in structural equation modelling.

**Measure:** Respondents will be asked to answer to the following four questions:

1. How many hours per week do you work for your company?
2. How many hours per week do you spend for consulting to your company?
3. How many hours per week do you work for academic institution?
4. What is the percentage of your employment at your company (in complement to employment at academic institution research)?

**Intention to become an entrepreneur**

Intentions are the single best predictor of any planned behaviour, including entrepreneurship (Krueger et al. 2000). Intentions correspond to a state of mind that directs the individual’s attention, experience, and action toward the goal of founding a business (Bird 1988). Entrepreneurial intentions also embody an individual’s commitment to start a new business (Krueger 1993).
Measure: We will use three items to measure entrepreneurial intention:

1. How interested are you in setting up your own business (5-point Likert scale ranging from 1 (not interested) to 5 (very interested)); Chen et al. (1998)
2. If you found commercial application for one or more of your inventions, you would seriously consider becoming an entrepreneur to commercialize the opportunity (5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)); Kassicieh et al. (1997)
3. How probable is it that you will start your own business in the next 5 years (scale 0-100); Krueger et al. (2000)

4.2. Independent variables

Personal networks
Close relationships provide entrepreneurs with avenues for negotiation and persuasion, enabling them to gather a variety of resources (e.g. market information, ideas, problem solving, social support, venture funding and financial resources) held by other actors (Shan and Stuart 2002, Hoang and Antoncic 2003, Nicolaou and Birley 2003a, Nicolaou and Birley 2003b, Walter et al. in press). Nicolaou and Birley (2003a) more specifically based on the literature review defined business networks as those which can benefit in:
- opportunity identification - the academic inventor is in an advantageous position to better identify market niches and may adapt his invention accordingly,
- access to important information and resources that could not otherwise be obtained,
- timing, where through business contacts the academic acquires the market information early, which can be of catalytic importance in research and development,
- receiving positive recommendations and evaluation at the right place through referrals. For example, venture capitalists and business angels are more inclined to invest in spin-offs that they know or that have been referred to them by reliable resources, because this tends to alleviate informational asymmetry problems (Shane and Stuart 2002).

Measure: Respondents will be asked to answer to the following three questions:
1. How many hours per month do you spend developing contacts with persons with whom you can discuss business matters (e.g. commercialization, marketing, finance...)?
2. How many hours per month do you spend maintaining contacts with persons with whom you can discuss business matters (e.g. commercialization, marketing, finance...)?
3. With how many people did you discuss business matters (e.g. commercialization, marketing, finance...) in last month?

Number of years spent at the academic institution
Most members of the academic community have by a tenure professorship guaranteed their socio – economic status which thus does not depend on applicative research, which provides basis for spin-off creation. Their job stability and academic reputation normally are dependent upon teaching and publication. Without taking sufficient precautions, a faculty member may jeopardize his or her academic career by engaging in spin-off creation while shirking basic research responsibilities (Lee and Gaertner 1994). Thus, the number of years spent at the academic institution is a proxy for their scientific seniority, which should negatively affect the level of academic’s entrepreneurial involvement and intention to become an entrepreneur.
Measure: The variable counts the sum of the number of years spent by academic founder at his or her academic institution.

**Nature of research**
In general, academic research is oriented more towards basic research, which is driven by a scientist's curiosity or interest in a scientific question, rather than applied research. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view (OECD 2002). Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective (OECD 2002) with market potential and thus more interesting for commercialization than basic research.

Measure: The variable refers to the nature of research carried out by academic or academic entrepreneur at the academic institution. It is measured with the following three questions:

1. How many hours per month are you involved in applied research?
2. How many hours per month are you involved in basic research?
3. What is the average percentage of research funds for your applied research (in complement to basic research)

Those who have already established a spin-off will be asked about their nature of research at the present time and about their nature of research before they established a spin-off.

**Motivational factors impacting academic spin-off behaviour**
In a recent exploratory study at MIT, Shane (2004b) uncovered motivational characteristics of academic entrepreneurs, such as (1) a desire to bring technology into practice (Samson and Gurdon 1993, Weatherston 1993, Corman et al. 1988, Shane (2004b)); (2) a desire for wealth (Roberts 1991, Shane (2004b)); (3) a desire for independence (Roberts 1991, Shane (2004b)), as key pull and push factors impacting academic spin-off behaviour. Besides those motivational characteristics of academic entrepreneurs that were discussed by Shane (2004b) there are some other motivational factors that apply for technical entrepreneurs and were discussed by other scholars (e.g. Roberts 1991): to do something others could not (challenge) and taking on and meeting broader responsibilities (challenge). Based on literature review and our knowledge of academic entrepreneurs, we additionally propose three other motivational factors that were not tested in the literature and that are impacting academic spin-off behaviour (1) desire to secure additional research funding, (2) dissatisfaction with the academic environment and (3) desire to pursue technological perfection - reverse.

Measure: Respondents will be asked to rate the extent to which they agree with following statements (on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)): (1) I am dissatisfied with the academic environment; I have a desire (2) to bring technology into practice; (3) pursue technological perfection - reverse; (4) to disseminate my findings through the scientific literature - reverse; (5) for wealth; (6) for independence; (7) to do something others could not; (8) for taking on and meeting broader responsibilities and (9) to secure additional research funding.

**Previous work with the industry**
At the institutional level, previous research on university-industry relation indicates that institutions with closer ties to industry generate greater number of spin-offs and exhibit more entrepreneurial activity, such as faculty consulting with industry, faculty involvement in new

Same applies also at the individual level. Blumenthal et al. (1996) surveyed 2052 academics at 50 universities in the life science field and found that industry funded academics are more commercially productive than those who are not industry funded. Similarly Mansfield’s (1995) study of 66 firms as well as 200 academic researchers found that in early stage of research projects, academics receive more government versus industrial founding, while as a project matured, industry founding began to grow and academics become more involved as industry consultants. Corman et al. (1988) found that 90 percent of entrepreneurs interviewed (20 of 22) were deeply involved in technical consulting activity before and often after launching their own firms. The Kassicieh’s et al. (1996) study found significant differences between entrepreneurs and non-entrepreneurs in terms of situational variables such as the level of involvement in business activities outside the laboratory. Colyvas et al. (2002) found in their examination of 11 case studies from Columbia University and Stanford University, that in all but one case, the researchers involved in spin-off were members of a network of scientists that included industry professionals. In the single case in which there was no academic and industry scientist linkage, the technology was never transferred.

**Measure:** Respondents will be asked to answer to the following five questions:
1. How many hours per month are you involved in consulting to companies?
2. How many hours per month are you involved in projects related to industrial partners?
3. What is the average percentage of research funds from industry for your research projects?
4. In how many industry-related projects were you involved in last year?
5. In home many networks of scientists that include industry professionals are you involved?

Those who have already established a spin-off will be asked about their work with the industry at the present time and about their work with the industry before they established a spin-off.

**Scientific publications**
Academic institutions typically do not reward activities such as commercializing research and creating new spin-offs in their promotion and tenure decisions (Siegel et al. 2003a), thus academics are usually more interested in publishing their results, presenting them at conferences, and continuing in the academic research race (Graft et al. 2002), rather than being involved in patenting and commercialization of the research. The academic reward structure encourages the production of knowledge that is a useful input into other academics’ research. Researchers wish to have their papers cited because this is a signal that they have established a reputation within the academic community (Goldfarb and Henrekson 2003), which is the primary motivation for university scientists (Siegel et al. 2003b). Different scholars have argued that publishing papers and striving for citations is a central objective of academic research, as citation measures are associated with higher income and prestige (e.g. Diamond 1986, Stern 2004) and also as a recognition from other scientists which may lead to election to a national academy and the ultimate accolade of the Nobel prize (Etzkowitz 1998).

The performance evaluation process and publishing-orientated research thus act as barriers to creation of new academic spin-offs (Ndonzua et al. 2002). There is little reason to believe that the goal of producing useful inputs into the research of other academics (which is done...
through scientific publications) is congruent with the goal of producing commercially valuable knowledge. Hence, efforts directed at the production of commercially valuable knowledge will most likely come at the expense of the production of recognized reputation of academic’s (Goldfarb and Henrekson 2003).

Importance of a reward system in academic institutions as barrier to creation of new academic spin-offs is also illustrated by Siegel’s et al. (2004) study, which was based on 55 structured interviews of three types of university-industry technology transfer stakeholders (managers/entrepreneurs, technology transfer office directors/university administrators and university scientists). They found that from 80% (managers/entrepreneurs) to 85% (technology transfer office directors/university administrators and university scientists) of interviewers identified an importance of modifying the reward system in universities to reward technology transfer activities, in improving the university-industry technology transfer.

**Measure:** Respondents will be asked to answer to the following questions:

1. How many scientific papers did you publish in last three years?
2. How many citations did you receive in last three years?

Those who have already established a spin-off will be asked about the number of scientific papers and citations in last three years and also in last three years before they established a spin-off.

**Role models**

Role models’ impact on entrepreneurial behaviour has been studied by many researchers and it has been found to correlate significantly with entrepreneurial behaviour and intentions (Roberts, 1991; Krueger, 2000). Once a university has established an entrepreneurial tradition, and a number of successful companies, fellow faculty members can offer material support, in addition to moral support to their colleagues who are trying to establish a company of their own (Etzkowitz 1998). Academics who have started their own firms can also become advisors to those newly embarking on a venture. The effort by pioneering faculty members to found companies can lead other faculty members to found companies as well, because it lead the followers to believe that firm formation was an easy and desirable activity (Feldman et al. 2000 cited in Shane 2004b). Similarly in a large sample study (although based on case studies), Audretsch et al. (2000) provides similar results, showing that science-based firm formation is in fact, influenced by a demonstration effect of prior start-up efforts by other scientists. Similarly conclusions were made also by Shane (2004b) and Etzkowitz (1998). Etzkowitz (1998) cited an aspiring academic entrepreneur that recalled that a department colleague who had formed a company, “gave me a lot of advice…he was the role model”.

The availability of such role models makes it more likely that other academics will form a firm out of their research results, when the opportunity appears.

**Measure:** Respondents will be asked to answer to the following questions:

1. How many academic entrepreneurs do you know personally?
2. How many entrepreneurs do you know personally?
3. How many hours per month do you spend maintaining contacts with academic entrepreneurs?
4. How many hours per month do you spend maintaining contacts with entrepreneurs?
Support from academic institution
Locket and Wright (2005) argued that there is a positive relationship between incentives and rewards for establishing a university spin-offs and the creation of university spin-offs. Siegel et al. (2003b) found out that barriers for university-industry technology transfer are also university aggressiveness in exercising intellectual property rights and bureaucracy and inflexibility of university administrators. Additionally, Degroof and Roberts (2004) proposed that spin-off policies in academic institutions significantly affect the growth potential of spin-off companies. Thus, if academic perceive support from academic institution, he or she will more likely become an entrepreneur or will easier be more involved as entrepreneur.

Measure: Respondents will be asked to rate the extent to which they agree with following statements (on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)):
1. Academic institution is too aggressive in exercising intellectual property rights – reverse (based on insights of Siegel et al. (2003b))
2. Bureaucracy and inflexibility of academic administrators impede the establishment of academic spin-offs – reverse (based on insights of Siegel et al. (2003b))
3. The marketing, technical and negotiating skills of the academic staff involved in commercialisation promote the establishment of spin-off companies (adapted from Locket and Wright (2005))
4. The availability of a clear process for establishing spin-off companies promote the establishment of spin-off companies (adapted from Locket and Wright (2005))
5. The availability of venture capital promotes the establishment of spin-off companies.
6. Academic institution provide facilities and access to research equipment to the spin-offs (based on insights of Steffensen et al. 1999)
7. There are good sources of assistance within the academic institution if one is interested in establishing a spin-off (adapted from Kassicieh et al. 1997)
8. Academic institution is supportive of academics who wish to commercialize their inventions (adapted from Kassicieh et al. 1997).

Patents
Patenting is a logical extension of the tendency toward increasing interest in commercially applicable results (Louis et al. 1989).

Measure: Respondents will be asked to answer to the following questions:
1. Number of patents you applied for in last three years?
2. Number of patents granted to you in last three years?

Those who have already established a spin-off will be asked about the number of patents they applied for and number of patents that were granted to them in last three years and also in last three years before they established a spin-off.

Entrepreneurial self efficacy
It is widely acknowledged that most scientist lack the business background needed to bring technology closer to the market (Druilhe and Garnsey 2004) and many established spin-off companies can be characterized by a lack of commercial awareness and may lead the company to become technology rather than market driven. Typically technology orientated entrepreneurs seeks to develop the absolute best “mousetrap” and constantly pursues perfection (Wilem 1991). Products never sell themselves: there is always the need for varying degrees of marketing and sales skills (Sljivic 1993). The ability to connect specific knowledge and a commercial opportunity requires a set of skills, aptitudes, insights and
circumstances that are neither uniformly nor widely distributed (Venkataraman 1997). Besides commercial knowledge new academic entrepreneurs also require administrations skills, since where previously all the administration was done by the university, spin-off company has to address these time consuming and distracting aspects themselves (Sljivic 1993).

The creation of a new venture by academics can be thus described as a process in which they are involved in both the invention and the commercialization exploitation phase (Grandi and Grimaldi 2005), thus they need both specific scientific knowledge and also business related skills or at least certainty in performing business related roles and tasks. The certainty in performing business related roles and tasks of entrepreneurs is entrepreneurial self efficacy, which is relatively more general than task self efficacy (Chen et al. 1998). Entrepreneurial self efficacy refers to the strength of an individual’s belief that he or she is capable of successfully performing the roles and tasks of an entrepreneur (Boyd and Vozikis 1994).

**Measure:** Entrepreneurial self efficacy will be measured with 22 roles and tasks identified by Chen et al. (1998). Respondents will be asked to indicate their degree of certainty in performing each of the following roles/tasks on a 5-point Likert scale ranging from 1 (completely unsure) to 5 (completely sure):

1. Marketing related roles and tasks: set and meet market share goals, set and meet sales goals, set and attain profit goals, establish position in product market, conduct market analysis, expand business;
2. Innovation related roles and tasks: new venturing and new ideas, new products and services, new markets and geographic territories, new methods of production, marketing and management;
3. Management related roles and tasks: reduce risk and uncertainty, strategic planning and develop information system, manage time by setting goals, establish and achieve goals and objectives, define organizational roles, responsibilities and policies;
4. Risk-taking related roles and tasks: take calculated risks, make decisions under uncertainty and risk, take responsibility for ideas and decisions, work under pressure and conflict;
5. Financial control related roles and tasks: perform financial analysis, develop financial system and internal controls, and control costs.

In Chen’s et al. (1998) study, Crombach alphas were 0.89 for Total entrepreneurial self efficacy, 0.86 for Marketing self efficacy, 0.74 for Innovation self efficacy, 0.75 for Management self efficacy, 0.65 for risk taking self efficacy and 0.77 for Finance self efficacy.

4.3. Controlled variables

**Planned or spontaneously occurring spin-off**

Steffensen et al. (1999) identify two types of spin-offs: (1) planned, when the new venture results from an organized effort by the parent organization, and (2) spontaneously occurring, when the new company is established by an entrepreneur who identifies a market opportunity and who founds the spin-off with little encouragement (and perhaps with discouragement) from the parent organization. Since in planned spin-off academics are much more influenced by parent organization (academic institution) we will control for this variable.
Other controlled variables
Gender, Age, Years since establishment of own company, Total years of employment, Percentage of equity in spin-off company of academic institution, Percentage of academic’s equity in spin-off company, Whether an establishment company arise from academic research, Number of entrepreneurs in establishing a spin-off and Highest professional degree attained at the academic institution (researcher, doctoral researcher, post-doctoral research associate, Assistant Professor, Associate Professor, Full Professor, other).

5. Propositions
To summarize our literature review, a conceptual framework for studying a technology transfer process and our understanding of technology transfer from academia to new firms, we propose the main research thesis and a set of 15 research propositions.

Main research thesis: Academic spin-off behaviour (entrepreneurial involvement and intention to become an entrepreneur) is from entrepreneur’s standpoint influenced by availability of personal networks of academics or academics entrepreneurs, number of years spent at the academic institution, nature of research (basic versus applied research), personal motivational factors, previous work with the industry, publishing recognizable scientific papers, availability of role models, support from academic institution, patenting and entrepreneurial self efficacy.

Proposition 1: There is a positive relationship between academic spin-off behaviour (entrepreneurial involvement and intention to become an entrepreneur) and size and frequency of interaction with persons with whom academic entrepreneurs / academics can discuss business matters.

Proposition 2: There is a negative relationship between the number of years spent at the academic institution and academic spin-off behaviour (entrepreneurial involvement and intention to become an entrepreneur).

Proposition 3: There is a positive relationship between applied research and academic spin-off behaviour (entrepreneurial involvement and intention to become an entrepreneur).

Proposition 4: There is a positive relationship between different motivational factors and academic spin-off behaviour (entrepreneurial involvement and intention to become an entrepreneur).

Proposition 5: There is a positive relationship between work with the industry and academic spin-off behaviour (entrepreneurial involvement and intention to become an entrepreneur).

Proposition 6: There is a negative relationship between publishing recognizable scientific papers and academic’s entrepreneurial involvement.

Proposition 7: There is a negative relationship between publishing recognizable scientific papers and academic’s intention to become an entrepreneur.

Proposition 8: There is a positive relationship between availability of role models (academic entrepreneurs) and academic’s entrepreneurial involvement.

Proposition 9: There is a positive relationship between availability of role models (academic entrepreneurs) and academic’s intention to become an entrepreneur.

Proposition 10: There is a positive relationship between support from academic institution and academic’s entrepreneurial involvement.

Proposition 11: There is a positive relationship between support from academic institution and academic’s intention to become an entrepreneur.
**Proposition 12:** There is a positive relationship between number of patents (applied/granted) of academic and academic’s entrepreneurial involvement.

**Proposition 13:** There is a positive relationship between number of patents (applied/granted) of academic and academic’s intention to become an entrepreneur.

**Proposition 14:** Academic entrepreneurs with high entrepreneurial self efficacy are more likely to be more involved in spin-offs they have established.

**Proposition 15:** Academics with high entrepreneurial self efficacy are more likely to become entrepreneurs than those with low entrepreneurial self efficacy.

6. **Conclusion**

We believe that the proposed conceptual framework for studying technology transfer from academia to new firms will help researchers, policy makers and practitioners in designing policy measures and instruments to foster technology transfer from academia to new firms. In further stages of this research the model and constructs will be first pre-tested with approximately 20 academics and academic entrepreneurs in Slovenia and Eindhoven area and than tested in three European regions (Slovenia, Eindhoven area and Cambridge area) for intercultural comparison.

7. **References**


Partnering of High Technology Small Firms with Universities
In Order to Commercialise ICT Research

Jeremy P. Reece
The School of Computing and Information Technology,
University of Wolverhampton,
Technology Centre (MI Building), Wulfruna Street, Wolverhampton, WV1 1SB. UK.
Email: j.p.reece@wlv.ac.uk
Telephone: (+44 1902) 321870
Fax: (+44 1902) 321478

Marc J. Fleetham
Business Development and Enterprise,
University of Wolverhampton,
Wolverhampton Science Park, Glaisher Drive, Wolverhampton, WV10 9RU. UK
EMail: m.j.fleetham@wlv.ac.uk
Telephone: (+44 1902) 824128
Fax: (+44 1902) 824290
Abstract
High Technology Small Firms are knowledge wealthy and also knowledge hungry, their research being focused primarily on the commercialisation of technology. Universities knowledge covers a broad spectrum of research, from commercially focused research, normally associated with new Universities, through to ‘blue sky research, normally associated with the traditional Universities. This paper explores the opportunities that exist through research partnerships; Universities realise the commercialisation of research developing a commercial focus in research and teaching; whereas the small firm enhances their technology, to incorporate ideas and concepts from a less commercially driven source. ICT is fairly unique, as not only can it be applied to ICT applications, but can enhance other high technology arenas. Due to its broad range of applications and fast rate of change, special means are required to identify and incorporate its use. This paper addresses the issues related to the commercialisation of ICT research from Universities into high technology small firms.

Introduction
The Authors of this paper have been actively involved in working with commercial organisations in order to facilitate the transfer of knowledge from a University environment in to commercial settings. The one author currently works on a European Regional Development Fund project, which engages with West Midlands SMEs, to develop their use of ICT, having previously held similar and strategic roles in the support of ICT SMEs. The other author has overseen over 70 Knowledge Transfer Partnerships; a UK Department of Trade and Industry scheme to facilitate the transfer of University expertise to industry; these schemes typically being of 2 years duration. The authors draw on their experience to demonstrate how high technology firms can successfully engage with universities.

High technology small firms are on the leading edge of technology in terms of their research; as are Universities, but both groups have a different prime emphasis for their research. Small firms are looking to provide solutions to their customers in order to remain profitable and to give the business the ability to grow through new product enhancements and diversification in to related product offerings. In contrast academics within Universities are looking to develop the body of knowledge within their field of research in order to enhance their reputation in their field, with the rewards to the Universities being to gain an enhance reputation for undertaking research and subsequently increased appeal to students, both undergraduate and post-graduate.

The challenge universities are now facing, in the UK’s education sector, is how to engage more pro actively with industry, for a more immediate result of enhancing graduate employability through a more commercial focused curriculum; but longer term for the greater gains that can be achieved through partnering with industry, in order to facilitate the transfer of the university’s intellectual capital in to commercial realisation, this leading to additional funding for research, enhanced teaching through real-life scenarios to aid learning and a enhanced commercial acumen for the institution.

Normally the commercial / university partnership is defined by the commercial partner having the infrastructure and market in order to commercialise the product and the university providing the intellectual capital from its research activities; the product concept being devised by either partner, or in collaboration. With high technology firms there is a different challenge, as a significant share of the intellectual capital resides within the firm itself; hence a new focus is needed to identify how the intellectual capital can be integrated and shared
between the two organisations. This paper aims to address how the partnership between the University and the commercial partner can be realised in order to optimise the benefits to both parties.

The paper’s discussion of universities partnering with high technology firms, leads to the identification of a roadmap to enable the successful commercialisation of ICT research. The paper includes: developing a foundation for the partnership in terms of responsibility and ownership of the intellectual capital, identification of what each party wants to gain from the joint project, the integration of the parties knowledge in to a structured project, the running of a project that can successfully deliver the objectives and how to ensure the project will exist beyond the initial collaboration to enable a long term relationship. Not only does the paper focus on the operational and positive aspects of a joint relationship, but it also identifies the problems that may occur and how they can be mitigated.

**ICT in / as High Technology Small Firms**

There are many definitions of what types of companies can be classified as high technology small firms and Cordes et al (1999) undertakes a good review of several versions. In each ICT is scantily addressed in Charles et al (1976) it is not even mentioned, although it could be argued that at this stage ICT was still in its infancy. In subsequent definitions it is still has a narrow classification covering such aspects as ‘computer and office equipment’; although it could be included in the other categories of ‘communications equipment and electronic components as listed in NSB (1993). What is significant of all of these definitions is that ICT is a rapidly changing technology and could still be considered to be in its infancy. As Nordström & Ridderstråle, (2000) identified it has ‘a phenomenal rate of change and shows no sign of slowing’.

Keeble et al (1998) wrote that ICT could be classified as high technology and identified that the number of U.K. computer services and software firms had increased by 16,000 (110%) between 1985 and 1993 and these were overwhelmingly smaller firms, to the point where ICT is playing a significant role in high technology small firms. This trend not ceasing with the advent of internet based technologies and more recently mobile computing technologies, with a significant number of the smaller firms worked with by the authors being in these newer technologies.

This paper is primarily focused on high technology small firms that produce ICT as a product or service, but in the modern era where the use of ICT can have a major impact on any business, it is difficult to differentiate between a high technology small firm that classifies itself as one of the other categories of high technology small firms, but has ICT as a major component of its product delivery. Hence this paper classifies a high technology small firm as one that meets the broad Cordes et al (1999) definition as:

“... whether developing or applying new technological knowledge plays an integral role in the competitive strategy of the firm. Using this approach, a firm would be classified as high tech if one of its primary assets was the possession of advanced technological knowledge used to develop new products or processes.”

Here we consider that one of its primary assets would be ICT. For example, an organisation may classify itself as aerospace, but employ and retain a significant intellectual capacity in ICT, for example, the one author worked for an aerospace company that employed 150 staff
on a aerospace software development project and was on the leading edge of research in to fly-by-wire / fly-by-light technologies; All of which clearly aligns itself to ICT. In an earlier paper Cordes et al (1986) did have one if its three classifications as ‘(i) the extent of technology embodied in products and production processes’, so there is some support for this argument.

**Preparation for Commercialisation in Small Firms**
Research has shown that SMEs have very distinct characteristics. On the positive side they are able to adapt quickly in the way they work, decisions can be acted upon quickly; they have close proximity to their markets and significant customer loyalty (Julien, Carrier, and Hebert 1988). This is believed to be due to SMEs operating within niche markets and having good relationships with their clients. Dupont (1986) sees their involvement in very specific markets as increasing their vulnerability, and implies that SMEs therefore have a limited number of products or services. In addition Bergeron and Raymond (1992) believe SMEs suffer from a lack of resources in terms of finance, information and people to develop a thorough understanding and analysis of their environment.

Bergeron and Raymond (1992) stated that the above characteristics affected the use of IT in SMEs, in particular they identified the lack of resources and the dependency on a few key individuals. In addition the companies studied supported the supposition that the potential to use IT is found throughout the whole of a SMEs operations. Here there has been found a potential contrast; where small firms classify themselves as ICT product / service companies they invest significantly (and wisely) in ICT related technologies, but other high technology firms who do not see themselves as primarily ICT related have been found (but not in all cases) to limit their expenditure on ICT related solutions and potentially be ‘blinkeried’ to the opportunities it may offer.

**HEI Characteristics / Drivers**
Castellenos et al (2004) identifies that intellectual capital is an important part of a universities endowment of intangibles. It is developed to give both direct and indirect benefits to society, whereas small firm research is more focused towards a more commercial benefit. Universities don’t on the whole actively manage their R & D capital in a structured manner in order to enable its transfer to industry. Although some authors have presented cases where this commercial focus has been developed within a university environment with Todorovic et al (2005) demonstrating an entrepreneurial approach in his case study and Garrick et al (2004) who advocate a more vocational focus for partnership with industry.

Robertson and Bond (2001) identified various reasons why academics research; including the linkage between research and its contribution to developing the transmission of advanced knowledge, providing a stimulating environment for academics and a global connection that encompasses the link between teaching and research for a department. In addition Castellanos et al (2004) identified the need to accumulate knowledge and develop multi-disciplinary research groups that can solve actual problems and create the acceptance of the university as the organisation that supports them in their relationship with companies, institutions and other bodies in society.

Todorovic et al (2005) found that entrepreneurship could be used to change the culture in order to create greater flexibility, innovation and adaptability within the academic researchers and
at the organisational level he identified the need to overcome ‘bureaucracy and paucity of interdisciplinary research’.

Jacobson et al (2004) in their research into the influencers that drove University based researchers to partake in knowledge transfer identified; Funding agencies that emphasised a need to demonstrate the scope for knowledge transfer in the bids from applicants for research grants; The increased pressure on budgets and increased corporation and commodification in society; They also identified the changes in the way Universities operate in order to enable effective knowledge transfer, although this does need a mutual, reciprocal arrangement with the academics. Although they do warn that the focus of Universities doing research for good of society risks being lost in the drive to meet the needs of corporate society.

The Mechanism of Knowledge Transfer

Bower and Christensen (2000) drew attention to the importance of knowledge-based strategies for business regarding the leverage of intellect to achieve competitive advantage. Stevens and Bagby (2001) stated that at the time of writing there were no existing frameworks, theories or empirical evidence that identified the relative payoff to all stakeholders of publicly subsidised university transfer of knowledge to business.

Whilst it is acknowledged that the ‘relative payoff’ can be difficult to assess, once the transfer process has been identified, attributes and deliverables can be assigned emphasising the transitional characteristics acquired by corporate partners.

As indicated in the figure above, the government apportions funding to universities for the generation of knowledge that can then be disseminated back into society via a cascading process. University generated knowledge is traditionally conveyed to business through co-operative platforms such as patents, intellectual property rights (IPR) contracts, spin-outs and joint venture initiatives with the originators.
Competitive advantage through Intellectual Capital

It can be argued that intellectual capital can only be truly commercialised through the realisation of competitive advantage. Nonaka (1994) argues that for an organisation to develop competitive advantage based on intellectual capital, they need to move through three stages (see figure below): This suggests that there are a number of phases involved in developing an organisation’s intellectual capital: individual learning to develop localised knowledge, tacit knowledge transfer to disseminate knowledge across the organisation and organisational learning to embed the new knowledge into the organisation’s procedures and unconscious actions, thus developing competitive advantage. This would appear to counter the earlier Stevens and Bagby (2001) claim that at the present time there are no existing frameworks, theories or empirical evidence that identifies the relative payoff.

Conceptual Framework (Nonaka, 1994)

“It is not sufficient for a firm to access useful knowledge. It has also to organise methods for the internal diffusion of new knowledge, to ensure that knowledge which is received from external sources is communicated and utilised effectively throughout the organisation.” Jones (2003)

Therefore, it will be necessary to offer further explanation into the three stages as mentioned above. A clarification into their collaborative interaction should illustrate their roles within knowledge transfer activity.

Organisational learning

Knowledge transfer has been demonstrated to be a major determinant in the survival or demise of the small firm. It is therefore clearly important to consider the activities of businesses (SME’s) in relation to learning and skills development facilitated through the collaboration with Universities. If the tacit knowledge held within organisations is to be maximised, businesses (SME’s) need to be persuaded to invest in their people. Academic theory, as previously stated, contends that true competitive advantage can only be achieved by exploiting the intellectual capital, and knowledge, contained within an organisation.
“The main producers of wealth are information and knowledge” Mullins (2002) clearly adds weight to the argument, yet fails to take into account the importance of an appropriate culture to act as the enabler.

**Barriers to Knowledge Transfer**

The ability to transfer knowledge quickly and effectively has been identified as one of the key attributes of a learning organisation. Others include the creation of a problem seeking and solving culture. A learning organisation is described as using these attributes, whereby individuals are encouraged to share knowledge in order for the organisation to learn as a whole. It has been proven that, without a culture of collaboration and co-operation being in existence, knowledge transfer cannot be achieved. Goh and Richards (1997). This suggests that organisational culture is of equal, if not more, importance than the actual knowledge to be transferred.

It is often stressed that many businesses, SME’s in particular, appear to be failing to fully exploit the information, knowledge, and skills in the knowledge-base embodied in universities Iles and Yolles (2002). The knowledge retained within universities is getting increasingly more difficult to develop in a commercial setting due to its complex legal, financial and administrative nature. Ever expanding management systems are being deployed in order to identify, co-ordinate and administer the process.

It has been found that working with academic holders of knowledge they traditionally impart research findings to other like-minded individuals by delivering a ‘paper’ through an appropriate forum such as a conference. There is a small core of academics who undertake commercial activity but the imparting of this knowledge in to the traditional academic arena is often less prolific, this is believed to being down to factors such as the amount of time that commercial research takes up and its commercial focus pressure that can impact a chosen research and teaching activities; and intellectual protection aspects of the work, which impedes the release of the knowledge via the traditional academic channels.

A key aspect Merton (1973) identified inhibiting the relationship between academics specifically and Industry are secrecy agreements that prevented academics from publishing, releasing or discussing their research results thus hampering the ability to enhance their academic reputation and use their research work in teaching. This can also impact the University as a whole in its use of intellectual property and confidentiality agreements, as once there are controls over the use of knowledge for a particular application it then makes it much more difficult to use in a related field. This impacts ICT being used for the subsequent use of a technology or technique, where it has already been used in an alternative high technology sector and constraints have been put on its use.

Normally these controls are for a set time period, but due to the fast moving nature of ICT even a short delay can have an a major impact on the currency of the research. For general high technology partnering Blumenthal et al (1996) identify a limit on publication of no more than two months, although they did find corporate sponsors putting on controls of over six months. With the competitive nature, fast exchange of ideas and quick implementation of alternative solutions even the shortest of these delays are excessive.

This view is supported by the findings of Harman (2002) who cites the dangers of university – industry research partnerships `compromising academic freedom and impeding the free
flow of research information’. What has not been found in the ICT related partnerships, is issues related to the research being compromised by conflict of interests and commercial pressures as identified by Weissman (2001) and cited in Harman et al (2002), it is believed this is due to the more open network of sharing of knowledge, enabled by factors such as the internet and the faster pace of technology being commercialised, both these leading to less pressure on secrecy and a greater focus on intellectual protection of application rather than technology. Although Harman (2002) in summary on the risks of University-industry research links does state that the benefits clearly outweighs the dangers, as has been found in the vast majority of cases of collaborative ventures in which the authors have engaged.

More specifically related to ICT related partnerships the greatest concern has been the intellectual property issues, as discussed in greater depth later. In terms of the focus on commercial activities the authors’ host University is a ‘red-brick’ University where the focus of research is often considered to be more commercially focused rather than ‘blue-sky’ research; hence the difference between the commercialisation realisation of the academic research and the needs of the small firm’s application is smaller. This differentiation being even smaller if not non-existent between the high technology ICT related small firm and the academic research. Here the focus is on matching the technology knowledge of both parties rather than bridging the gap between the academic and high technology small firm’s research.

![Diagram of Organisations and the Types of Research Undertaken](#)

If we consider the diagram above, we can consider that in terms of research we have an overlap between University and high technology small firms research this is where the collaborative set of working is being focused at, but in addition there may be opportunities to extend the research in to more advanced research that can assist the small firm to further enhance its product offerings.

The motivations to acquire research range from peer group acceptance and pure academic achievement, to further exploration within an area that holds a particular interest. Commercial opportunities very rarely play any part in the thought process. Due to the ICT arena being fast moving it has been found that the latest trends in ICT are very quickly commercialised. This means that the academic research is very much at the point of being commercialised; hence the barriers to partnership are reduced, it also gives benefits to academics as it can quickly
give a set of commercial case studies to feed in to teaching; hence commercial application of technology is more significant to the academic approach.

Acceptance of commercialisation and collaborative possibilities can be an insurmountable barrier to the release of knowledge. It is only through the provision of on-going internal development that mind-sets can be broadened to encompass commercial knowledge transfer alliances. Internal constraints found within the knowledge bases (Universities, in this context) still represent by far the greatest challenge to the effective transfer of knowledge via the collaboration with a commercially orientated partner.

**Benefits of University–Industry Research Links**

The emphasis that has been put on Universities, both internally through commercial pressures and externally through government policy, to develop their links with industry has produced impressive results as Harman and Sherwell (2002) described the benefits including a greater involvement in R & D by academics, greater financial resources for Universities and financial and career opportunities for PhD students and most importantly a significant expansion in technology transfer and a focus on commercialisation of research. In addition it has been found that there are greater career opportunities for undergraduate students, particularly as there is an emphasis on vocational sandwich years. With this increased relationship with industry there is a more relevance to the curriculum being taught and a more real-life emphasis for the material that is taught to students. Specifically Harman and Sherwell (2002) identified that

“Universities have benefited from access to important technical know-how while industries have benefited from accessing the results of basic research and facilities to conduct research.”

Hendry et al (2000) identified the key reasons why SMEs in the High Technology sector should engage with Universities:

“The three key reasons for doing so are informal engagement with experts with relevant scientific and engineering knowledge, recruitment of scientific and engineering personnel, and collaborative research on both product and process improvement.”

Universities being well placed to deliver in each of these areas through academic research, post-graduate researchers and graduating students.

The key to developing the relationship between the University and High Technology Small Firm is to match the societal focus of the HEIs research as identified by Castellenos et al (2004) to the commercial focus of the High Technology Small Firm, where research has to be very focused towards financial returns as financial constraints place a significant burden on the growth of high technology small firms as identified by Westhead and Storey (1997).

Siegel, Waldman and Link (1999) as cited in Hall et al (2001) identified the most significant barrier to industry / University technology transfer as the lack of understanding on both parties to each others norms and environments of working.

An initial trepidation may be found in the development of this relationship as industry has been found through practical experience to identify academics with being boffins and unable
to realise blue-sky thinking in to commercial solutions. In practice after an initial period of settling in, it has been found that both parties can develop a mutually beneficial relationship from which both parties drivers can meet. An example of this has been a company that has developed over a 6 year relationship a doubling in the staffing levels of the business to over 400 staff, a whole new business area and enhancements of its traditional offerings. The business was seen as a leader in its delivery of its services.

In their study on technology intensive small firms and partnering, Varis et al (2004) found that these firms are looking for resource alignment in partners that can complement their weak sides whilst helping to leverage the strong sides in the technological capabilities and resources. This offering both opportunities and cautions for the University partner, on the one hand it will give scope to match the University’s capabilities to meet the firms, but on the other hand, it means the emphasis of research will be placed on the University; hence ownership of Intellectual Property will need to be shared appropriately. As a cautionary note Das and Teng (2000) identify that there is a need for the resources to be dissimilar and complimentary in the partnership, otherwise they will be wasteful.

**Intellectual Property**

One of the key issues that affect a high technology small firm from developing a relationship between a University and an SME is the protection of Intellectual property and protecting proprietary knowledge Hendry et al (2000). Hall et al (2000) identified that intellectual property issues between firms and universities do exist and they can in some cases provide insurmountable barriers to achieving the sought after research barrier. In practice negotiations for major research contracts have been found to hinge around ownership of intellectual property, where it can be a barrier in finalising contracts. In other cases high technology small firms have developed products for which they own the intellectual property and the University has the knowledge to enhance the product through innovative technologies. Here there is the need to divide the intellectual property in to two clear categories. The application of the technology into a specific product for which the firm maintains ownership and the technology for which the university maintains the ownership. This protects the firm from the university working with competitors, who could compete in the application area of the technology; whilst enabling the university to work with firms who can exploit the technology in unrelated applications, outside the scope of the original firms patent.

Hall et al (2000) gives clear outlines as to how the objectives of industry and universities regarding intellectual property differ, with these conflicting objectives causing the partnership to fail, or even not start. Drawing on the work of Brainard (1999),

> “The goal of business and universities in producing and protecting intellectual property is innovation for the protection of revenue. Beyond this ultimate shared goal, the interests of universities and business diverge. Universities value intellectual property not only as a revenue-producing resource, but also as a tool in the advancement and dissemination of knowledge. These divergent interests can result in conflicts...”

With high technology small firms this is more complex, as both parties posses intellectual capital on the technology being developed. Intellectual property rights need to reflect this, giving both parties the flexibility to do unrelated development work without infringing the original patent. Transparent negotiation to scope each parties access and use of the intellectual property is required, with the use of intellectual property specialists being
recommended. A good intellectual property agreement will aid in the natural expansion of the intellectual property through the collaboration.

High technology small firms also have the characteristic of often having been specialists who have moved out of larger firms; hence they are either likely to have limited knowledge of intellectual protection, or in the converse to be very protective of their intellectual property, as they may have had to go through legal proceedings to wrest the intellectual property from their previous employers who may have laid claim to it. Small firms are consequently very cautious and protective of their intellectual property, having had ‘their fingers burnt before’.

Hall et al (2000) found that where previous experience has occurred, of working on joint partnerships between universities and firms, where intellectual property has been involved, there is less likely to be insurmountable barriers to the agreement of intellectual property; as both parties will be aware of the difficulties that may occur. In addition, they identify where there is a lower desire to make intellectual property public, for say as part of academic papers, and where there is less certainty over the intellectual property characteristics of the research, the barriers to intellectual property agreements are less.

**Running the Project**

Typically project teams follow Tuckman’s (1965) stages of forming and hence the first few months are critical in developing a performing working relationship. Academic partners are familiarising themselves with the commercial focus of research; whereas the firm is looking for immediate results. These initial stages can be facilitated by i. defining clear guidelines of the work to be undertaken and the expected outcomes with their commercial and academic benefits. ii. short term projects can give a focus for the relationship to gain quick wins and reassure parties of the benefits of collaborative working. Ideally these are part of the main research. iii. close collaboration between academic and commercial staff should be planned, e.g. regular meetings and facilities where staff can come together and work.

Todorovic et al (2005) identifies the need for the university to have the right people involved to develop entrepreneurship. It has to modify its structure so the organisational culture moves to the outcome of innovation. The staff being involved requiring a significant tolerance to risk.

In order to facilitate the University-Industry partnership in terms of ICT Nordstrom & Riddersdale (2000) gives a general overview of managing stating it cannot be managed through traditional academics or through financially focused MBA graduates; It needs a virtual community where knowledge flows are empowered and minds and strategic visions are aligned.

Williamson and Mann (2002) more specifically describe the CITRUS model, which was implemented for the ICT community of New Zealand in order to develop the relationship between university and industry, they describe it as

“..Research projects could be in-house or with industry partners but will always be focused on adding real economic and social value into the regional economies with particular focus on the SME sector.”

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They also identify the problem that what is cutting edge one year, is common practice the next year and outdated shortly afterwards; hence the model needs to be flexible and responsive to change.

In order to implement this they looked to create:

“...incubation and business development models and by building relationships with key business development organisations nationally and regionally.”

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**The CITRUS Model: Hub, clusters and partners (Williamson and Mann 2002)**

The University of Wolverhampton model for developing University-industry relationships consists of a central department (BDE) which provides general project support, in terms of ICT related activities, this department provides specialist non-technical advice in areas such as grant applications and legal aspects e.g. intellectual property. This allowing the academic focus to concentrate on delivering the technical aspects of a project in order to meet the needs of stakeholders:

One of the key focuses the University adopts to ‘pump prime’ collaborative working is to obtain public sector funding to provide grants to assist SMEs in getting started in the creation of research capital through the partnership with academic researchers. This has provided both a caveat to encourage SMEs to engage with industry through free assistance and grant assistance towards the cost of research. This provides funds to free the academic from his normal duties in order to provide support to industry partners, as well as enabling the employment of staff to implement the research outcomes e.g. programmers and technical support staff.
Support mechanisms are put in place to identify and obtain funding to enable the commercialisation of ICT, as well as providing specialist staff in issues such as financial controls, intellectual property and application for grant funding. Thus helping to ensure the requirements of funding bodies are met and that agreements made with SMEs are appropriate to protect both parties. In issues such as intellectual property the focus is aiming to reassure the SMEs, thus helping to maintain a longer term relationship.

A structured quality manual within BDE incorporates a Service Level Agreement with all Schools detailing the scope of their involvement. This includes help in compiling the application; organising board meetings; undertaking the full recruitment drive etc... The rest of the manual details the operational parameters enabling ‘new’ members of staff access to information, should they require it.

Identification and targeting of potential partnership organisations is done through both the centralised department and school. Schemes that initially offer free assistance are used to primarily provide a beneficial outcome to the firm supported, but also make the industrial partner aware of the much greater potential that is available from longer term relationships. Once a longer term relationship is developed there is a continual focus on not only the current research / knowledge transfer that is being undertaken but also what is the latest technology that the parties can embrace in order to enhance the product; subsequently maintaining the working relationship.

Encouraging academics to engage with industry has proven to be a slow process; it has been seeded by a few academics that are confident about undertaking an industrial focused way of working. When academics hear about what their industrially focused colleagues are undertaking they are interested in engaging, but lack the support to engage. Thus mechanisms are needed to support academics in developing these relationships and freeing up their time to undertake industry related work. Currently these are informally done, although it is believed a more structured approach could be used.

Funded methods for collaboration include i. the Knowledge Transfer Partnership where a high calibre graduate is employed to undertake a major strategic project over two years. ii. European funded projects that can provide 5 days free assistance and development facilities, the problem here is the limited amount of research that can be done in 5 days. iii. Spinner project that enable the partnering with academic expertise to spin out expertise in to new companies, in relation to ICT there is a need to act quickly in order to overcome the problems of the rapidly moving market.

The key to this collaboration is public sector funding, but the project and methods of working are starting to develop links that are fully funded joint ventures, these being in their infancy stages and primarily consist of consultancy and post-graduate projects. The longer term relationships have also increased the number of opportunities for working with industry and subsequently increased the academic engagement. In 2000, within the School of Computing and IT, there were approximately 3% of academics actively involved in industrial partnerships, whereas now the figure is closer to 20%.

Conclusion
High technology small firms and University partnerships are different to normal research partnerships in that both parties provide intellectual capital and the High technology small
firm is likely to consist of experts in their field. This doesn’t necessarily mean a more complex project, but it does require a more equitable way of sharing the intellectual property rights, so as to not restrict either party in their future research and its application.

Conflict can exist between the academic focus of developing research in order to enhance academic standings and the industrial partner’s commercial focus. In contrast the benefits can far outweigh the negatives, through giving additional research funding, enhancing the commercial focus of teaching and providing research / career opportunities for post graduates. Where projects are suitably structured these negatives can be mitigated.

Various models have been put forward to develop University-Industry relationships. These primarily consisting of two broad aspects; one is developing the academics and industrial partners awareness of the needs of the partners drivers so they can plan and assist each other in meeting them; the other is to put into place support structures that can assist in the financing and management of the non-technical aspects of the project.

References


NEW VENTURES’ ENTRY STRATEGIES IN THEIR START-UP PROCESSES

Sari Roininen (corresponding author) and Håkan Ylinenpää

Corresponding address:
Sari.Roininen@ltu.se

Affiliation:
Entrepreneurship
Dept. of Business Administration and Social Sciences
Luleå University of Technology
SE-97187 LULEÅ
Sweden

Abstract

This paper departs from the basic understanding that venture creation processes are not uniformed but dependent on situational and contextual factors. In focus here is the impact of the new ventures’ knowledge level (e.g. technology). Following a case-study based design, two types of new firms are studied; academic spin-offs and generic ventures. Six new venture founders, three academic and three generic ventures, described their start-up process from idea generation to today’s business activity with the purpose of explaining their specific start-up process. The findings show that generic ventures and academic spin-offs have different basis for their venture creation and follow different strategies to enter a market. The academic spin-offs are to a larger extent product oriented and enter a market through a technology push where new products and services require the company to educate their customers in order to enable a proper use of their products/services. The generic ventures, on the contrary, enter a market through market pull where they exploit potential demands or opportunities/imbalances. These differences implicate venture gestation processes that imply differences also referring to the firms’ strategies for market entry and resource requirement and configuration.

Keywords: new venture, academic spin-off, start-up process, entry strategy, resource configuration.
New ventures’ entry strategies in their start-up processes

Introduction

Although previously studied, one of the least understood features of modern societies is still the process of creating a new venture (Reynolds & White, 1997). Even less studied is the phenomenon that this paper high-lights: differences between different categories of start-ups. As Deakins (1999) notes, every new venture is unique and the facilitating factors that might lead to a successful business start-up vary. Basic factors that might imply different start-up processes are; the nature or specific characteristics of the product/service the firm seeks to commercialize, the market that new ventures targets, and the resources and the market entry strategies that are required for commercialization. In focus here is the difference between knowledge-intensive academic spin-offs and “normal” or generic new business start-ups. A main concern in this study is how different product and market characteristics may be understood to relate to different market entry strategies and different modes of acquiring and organizing the firm’s resources during the start-up process as well as to different consequences in terms of firm growth and revenues. We address the theme of this paper by comparing two types of entrepreneurial endeavors: the start-up process of academic spin-offs (requiring specific and high-level knowledge) versus the process of starting a normal, generic new company (requiring a lower level of specialized expertise). Following Shane, Locke & Collin’s (2003) definition, we by entrepreneurial endeavors mean “the processes by which opportunities to create future goods and services are discovered, evaluated, and exploited”. In other words, we focus on the development of a new venture where one or more founders can make use of, commercialize, and further develop their business idea. The following text starts by developing a theoretical frame of reference for the study. In the next section we describe the methodology utilized for collecting the case-study base evidence followed by the case study results. We then conclude by discussing the results and research implications of the study.

A theoretical framework

Start-up process

Bygrave (1989) states that every firm’s start-up process is a disjointed, discontinuous and unique event and can, according to Lindholm Dahlstrand (2004), involve different intangible success factors. Therefore, there is no ready-made solution to the issue “how to successfully start a new company”. However, some stages or phases in a start-up process are common for all new ventures. This has triggered several researchers to try to “map” the start-up process. A typical and well-spread model depicting different phases in the start-up process was in 1999 developed by Deakins (and later utilized and further developed by Lindholm Dahlstrand, 2004). This model, which has been adopted as a theoretical framework for this study, includes different phases of the new venture creation process; i.e. the idea formulation, opportunity recognition, pre-start planning and preparations for the venture start-up, the ventures establishment and launch, and, finally, post-entry development.

Lindholm Dahlstrand (2004), Audretsch, Houweling & Thurik (2004), Shane (2000), Deakins (1999) and Venkataraman (1997) all point out that the idea formulation in a venture’s start-up process is to a high degree dependent on the entrepreneur’s prior knowledge and experience. For example Lindholm Dahlstrand (2004) concludes that many Swedish technology-based
ventures are created on knowledge from the entrepreneur’s earlier company employments or from an employment or studies at a university. In addition, entrepreneurs can make use of their established networks (both social and work-related) and their knowledge about markets in order to acquire competitive advantages, as well as financial support (ibid). The track record of a venture or an entrepreneur is crucial to the credibility among established actors like investors, customers and suppliers (Hitt, Ireland, Camp & Sexton, 2002, and Cooper, 2002). From this perspective, ventures started by younger entrepreneurs may, regardless if they are high- or low-tech, find it harder to create a new venture because of their lack of developed networks and track records.

A key factor in the start-up process is to transform the developed idea into a business opportunity (Lindholm Dahlstrand, 2004, Deakins 1999). An important factor for transforming an idea into a vital venture is the individual’s inner drive. Shane, Locke & Collins, (2003), Klofsten (1998), Crant (1996) and Adizes (1987) state that individual motivation, the inner drive, and the personal engagement in the new venture need to be above the level of a hobby activity in order to succeed. The individual motivation is far more important for a new venture than a flawless business idea.

In a pre-starting phase the entrepreneur needs to investigate the possibilities to business financing, which is especially important for a technology-based venture (Lindholm Dahlstrand, 2004, Deakins, 1999). In addition, in order to succeed it is equally important to do market research that for the entrepreneur and his/her stakeholders demonstrate that there is a profitable market for the new venture (Deakins, 1999). Moreover, the market segment selection is important in order to maintain the core focus of the product/service (Klofsten, 1998), something that is particularly important for high technology ventures. In this stage the entrepreneur has also to prepare for the venture’s organization, which, according to Storey (1994) and Sexton & Kasarda (1992), can benefit from a team of founders instead of a single founder due to the fact that several founders also may facilitate access to a broader range of networks and experiences. However, it is important for the venture’s success that knowledge and experience of the team is complementary, and that its personal characters match each other (Lindholm Dahlstrand, 2004). As an alternative to recruiting staff on their own pay-roll, new ventures should consider building alliances and coalitions with external actors (Klofsten, 1998).

When a venture is about to entry a market, timing is essential to the venture’s success (Lindholm Dahlstrand, 2004, Deakins, 1999). This is particularly significant for a new venture that launches new products because of the first mover advantages, i.e. it is easier for the innovator to get larger market shares than it is for its followers (Lee, Lee & Pennings, 2001, Grimm & Smith, 1997). A presumption is of course that the market is mature and ready, or that the venture with limited efforts can influence it to accept and demand the new product. To launch a new product may also necessitate the venture to educate their customers in how to make full use of their products, which is associated with high expenses for the venture (Lindholm Dahlstrand, 2004). Further, if the new product is introduced to an immature market, the customers’ demand needs to be strong enough for them to be willing to pay for the product (Lazonick, 2005), and there are risks for followers as soon as the market matures (Porter, 1985). During this phase resources such as patent holdings, brand equity, and other potentially valuable resources (Mosakowski, 2002) as well as elaborate market research can be essential and protective for the idea (Lindholm Dahlstrand, 2004).
Finally, as soon as a new venture has been established the venture will develop relations with its stakeholders and other actors. Therefore, the venture’s most important task is to build up their track record and liability in order to obtain the required financing, acquire customers, and to be able to get credit from suppliers (Lindholm Dahlstrand, 2004, Deakins, 1999). To facilitate the start-up processes and the ventures’ liability the firms can build alliances (Lee, Lee & Pennings, 2001) with customers in an early phase, where customers may take part in product development and act as investors. These customers should especially be those who need the product/service the most (Klofsten, 1998). To build awareness among customers, the venture has to distribute information about the product on a long term basis, especially if the product is innovative (Klofsten, 1998; Kotler, Armstrong, Wong & Saunders, 1996). Generally speaking, building different kinds of networks is important during this phase, because ventures who manage to build reliable networks with people at important positions often have a higher likelihood of succeeding (Politis, 2005).

Antecedents for entrepreneurial endeavors

Entrepreneurial events and processes may also be studied with a point of departure in the product/service that is offered to a market (supply side) or “the market-opportunity seeking behavior” (Hendry et al, 1995) that opportunity recognition and exploitation involve (demand side). This classic “divide” has paved the way for two research streams in entrepreneurship research: (1) Research that, following Schumpeter (1934), has been interested in how new market offerings (new products, new production methods, new ways of organizing business activities) cause “creative destruction” by facilitating for innovators to gain competitive advantage on the market; (2) Research that, building on Kirzner (1973) and others, has been more interested in how entrepreneurs seize imbalances and opportunities on the market and exploit them to their own benefit. Even if most modern research in the field understands these two streams as “two sides of the same coin”, they involve fundamental differences. “Schumpeterian” entrepreneurship research may hence be understood to highlight the role of “technology push” (e.g. new innovative products based on new knowledge or new combinations of knowledge) and the entrepreneurial role of destroying existing market structures by introducing more favorable solutions to customers’ problems (thereby creating “imbalances” in a previously stable but less dynamic economy). “Kirznerian” entrepreneurship research, on the other hand, underlines the function of the entrepreneur as someone who exploits an unfilled market need (market pull) and thereby creates a “balance” between demand and supply on the market. Although not transparent, the distinction between innovation and opportunity recognition relates to another dichotomized concept: the difference between proactive and reactive entrepreneurs. Crant (1996) suggests that individuals and firms with proactive motives have better qualifications to create new prosperous ventures since they create their own competitive environment, identify new opportunities and act upon them with persistence. With innovative advantages the venture can achieve high returns if they are being fast and first on the market (Lee, Lee & Pennings, 2001). First movers are those who first introduce new products or services, which brings “monopoly profits” until imitators or substitutes come out at the market (Grimm & Smith, 1997). On the other hand, several studies in e.g. product development have identified the risk associated with a “pioneering strategy”, implying that a more reactive “follower strategy” is beneficial for long-term firm growth and revenues (Bodin, 2000; Cooper & Kleinschmidt, 1993; Bain 1956). Recognizing that innovation and opportunity recognition in practice often are interwoven concepts, we still find the distinction between these two basic types of entrepreneurial endeavors (as well as the degree of matureness of the targeted market) as a first interesting theoretical building block for this paper.
Previous research hence state that entrepreneurs discover opportunities related to their prior information and knowledge, such as education, work experience or other means (cf. also Politiis, 2005; Audretsch, Houweling & Thurik, 2004; Klofsten, 1998; Venkataraman, 1997; Roberts, 1991). Information and prior experience influence the entrepreneur’s ability to comprehend, interpret and apply new information in ways that those lacking that prior information cannot replicate (Roberts, 1991). Entrepreneurs will therefore normally start new firms in an attempt to exploit different ideas based on their previous knowledge and experience. Shane (2000) and Shane & Venkataraman (2000) state that the source of entrepreneurship lays in the difference in information about opportunities, and that individual differences influence how these individuals discover opportunities. This is in line with the Austrian framework argument that discoveries of entrepreneurial opportunities depends, to a certain extent, on the distribution of information in society where the possession of the distinctive information allows people to see different opportunities (Kirzner, 1973). Moreover, the discovery of entrepreneurial opportunities is an ability to identify commercial opportunities rather than an optimizing process; therefore the entrepreneur needs to see new means-ends relationships in order to combine existing concepts and information into new ideas (Shane & Venkataraman, 2000).

Opportunities are however not always (or even primarily) discovered and exploited by a stand-alone-company. With the intention of competing effectively on markets, firms are increasingly using alliances and networks both to get access to information (e.g. market or technology information; cf. Ylinenpää (1999), and to acquire and build necessary resources and capabilities (Johansson, 2006; Wincent & Westerberg, 2006; Ylinenpää & Westerberg, 2004; Hitt, Ireland, Camp & Sexton, 2002). This allows firms to compete in markets without first possessing all the resources needed (Cooper, 2002), and enhances new ventures’ chance of survival and eventual success (Baum, Calabrese & Silverman, 2000). Moreover, networks can create legitimacy for new firms, especially if they are focused on creating a new market or a niche within an established market, since alliances can lead to exchange relationships with entrepreneurial firms’ customers (Cooper, 2002). In addition, Cooper states that ideas for new ventures often come from social networks, and that the creation of new ventures is based either on network ties of an individual or of entrepreneurial teams. Thus, networks are sources of entrepreneurial opportunities.

Strategic alliances, as well as strategic networks have, according to Hitt, Ireland, Camp & Sexton (2002), become highly popular means of entering international markets, and according to Deakins (1999) new ventures need to establish networks that might help them to break into new markets. International entrepreneurship is an innovative, proactive and risk-seeking behavior that crosses national boards and intends to create value in organizations (McDougall & Oviatt, 2000). New information technology facilitating international transactions and the opening of new global markets have led to increasing numbers of small ventures entering international markets (Ireland and Hitt, 1999). In this international entering, Lu and Beamish (2001) found that small firms experience greater profits when they engage in alliances with local partners in the new markets.

An emerging theoretical framework

From the literature review above a theoretical framework serving as a guide for empirical analysis may be generated. The context of this framework is a time-based sequential model for “normal” or “ideal” new venture creation processes, developed on the basis of Deakins
(1999) and Lindholm Dahlstrand (2004). The focus in the framework consists of key concepts that we have identified as important for developing a better understanding of our research purpose: to identify how different product and market characteristics may be understood to relate to different market entry strategies and different modes of acquiring and organizing the firm’s resources (resource configuration) during the start-up process as well as to different outcomes in terms of firm growth and profit. The basic idea of the framework is that the mode of resource configuration, entry strategy and the product/market characteristics affect the new venture’s start-up process. At the same time the start-up process per se can affect the entry strategy, the resource configuration and market characteristics as well. This is in Figure 1 illustrated by two-way arrows.

Figure 1. A theoretical framework of a new venture’s start-up process

In other words, the nature and level of a firm’s resources (i.e. its tangible as well as its intangible resources) can affect the idea formulation, the way the firm recognizes opportunities, the planning and perpetration of the creation of a new venture, the market approach and how the venture is developed during and after being launched into the market. Likewise, the chosen entry strategy and the characteristics of both the ventures’ products/services and markets impacts on decisions referring to planning and implementation of the new business concept. At the same time, the start-up process with its activities and events (and not least, the learning such experiences often involve) should affect the emergent entry strategy, required resources or the final product development since market research and different preparations may call for modifications and strategic shifts along the way.
Method

In order to arrive at a proper understanding of the new venture creation process, we need a more holistic understanding of the phenomenon that devotes interest in both the process itself as well as in important factors related to the phenomenon under study. Moreover, case studies have a distinctive place in evaluation research (see Patton, 1990, and Guba & Lincoln, 1980). First of all, case studies are important when the investigator tries to explain the presumed casual links in complex real-life interventions. Secondly, case studies are essential when an investigator wants to describe a course of events in a real-life context (cf. Yin, 2003; Miles & Huberman, 1994). Since the intention of this study was to analyze and compare two types of start-up processes, namely the academic spin-off creation and the generic venture creation, and also to explain why the start-up processes appeared to be as they were, a case-study approach was chosen (cf. Yin, 2003).

Criteria used for selecting case-study firms were that they from the start should have operated for at least three years; that the firms were small (SMEs), that the firms were either manufacturing or service companies; that the firms were developed in different milieus (different situational and contextual conditions) and finally, that the growth rate varied. These criteria were chosen in order to get more thorough and varying information about different ventures’ start-up processes as well as different influencing factors with the intention to be able to identify patterns (Miles & Huberman, 1994). Case studies were made in three generic ventures; A-Trade, B-Trade and C-Trade, and in three academic spin-offs; X-Tech, Y-Tech and Z-Tech. Some basic data on the case study firms are depicted in Table 1 below:

Table 1: Basic data on case-study firms at the time of data collection

<table>
<thead>
<tr>
<th>Business concept</th>
<th>No. of employees</th>
<th>Annual turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-Trade</td>
<td>3</td>
<td>1,44 MEUR</td>
</tr>
<tr>
<td>To offer software that increases computer performance, and complete computer sets and appurtenant services, foremost to computer enthusiasts but also to other interested customers, primary in Sweden.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-Trade</td>
<td>2</td>
<td>0,53 MEUR</td>
</tr>
<tr>
<td>To offer kiosk products of good quality and with a high degree of service to a local market.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-Trade</td>
<td>0</td>
<td>0,01 MEUR</td>
</tr>
<tr>
<td>To offer designed products with the optimal design and function to private persons, organizations, wholesalers, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-Tech</td>
<td>15</td>
<td>1, 06 MEUR</td>
</tr>
<tr>
<td>To offer the possibility to integrate and work with each other through their computers where people are able to talk and see each other, chat, share documents, use a whiteboard and surf the web together, regardless of their geographical location.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y-Tech</td>
<td>4</td>
<td>0,42 MEUR</td>
</tr>
<tr>
<td>To offer research- and EU-project participants the possibility to work with each other using distance-spanning information technology. The participants are able to work with and share documents, manage, control and plan the project through a custom-made project tool at the Internet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z-Tech</td>
<td>0</td>
<td>0,21 MEUR</td>
</tr>
<tr>
<td>To offer companies a 3-D motor, which they can integrate into their products (games), and to offer people possibilities to play virtually advanced games at the Internet.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The empirical data were collected through personal and open-ended interviews with founders of the ventures where they described their start-up process and different factors and events that influenced this process. The personal interviews were semi-structured in which the
respondents were told to recall and describe how they have progressed through their professional lives from completion of their education until the time of the study, to explain decisions during their carrier and how these decisions affected their further carrier. A major reason for using a semi-structured approach was to get more detailed information and to ensure that the discussion was driven by what the respondents felt was important in order to stay as close as possible to their lived experience. However, if the respondents could be assumed to leave out important information referring to, e.g., different phases of their development processes, more specific questions were posed on these matters. In order to validate the information, every interview was concluded by constructing a “rich picture” where a time line was drawn on a paper and different events and experiences that influenced the respondents’ decisions were noted. Each interview lasted about 2½ to 3½ hours. In addition, information was also assessed from the ventures’ websites, from a business database and by studying other printed materials about the ventures.

Findings

As could be expected, the start-up processes in the two categories of new ventures reveal both similarities and differences. What will be in focus in this paper are differences between academic spin-offs and generic ventures. First, however, we present a summary of the findings related to the two groups of new venture start-ups where characteristics related to key concepts/variables in our theoretical framework are specifically highlighted.

Academic spin-offs

Product characteristics: The original business concept in all spin-off companies originates directly or indirectly from academic research. This means that the products and services offered are knowledge-intensive and preferably high-tech. The founders of the academic spin-offs recognized an opportunity to create a product-based business based on their previous experiences and knowledge, and they developed a product for some years parallel to their previous positions as researchers or students. Due to the significant time required for developing market-ready products, all three academic spin-offs have started their businesses by also offering services or consultant offerings as a complement to their product offer to generate a required cash-flow. These knowledge-based services connected to the product have been essential for the product users and enabled for the companies to develop additional services generating important revenues. The products/services were further developed in cooperation with the university, where the university served both as a pioneer user and customer.

Market characteristics and entry strategies: The aim for all these ventures is to achieve world leadership in their specific niche - and to earn money. Recognizing the limited size of the regional and national market, these new ventures hence already from start chose to market their products on an international market. One of the ventures, Z-Tech, had to restructure their business idea and modify their product twice since they learnt that they did not have the competitive advantage required to successfully compete against existing large companies. The firms’ innovative products were offered to an often immature market and, as a consequence, these ventures normally had to educate their costumers in how (and why) to use the product. X-Tech hired two retailers in the US who knew the market five years after their start-up, and one in Europe a year later, in order to reach the customers and to offer them the product and service. Z-Tech had difficulties in reaching their target customers but got into contact with Sun Microsystems early in their start-up process and from them received assistance in their
marketing since Z-Tech had based their product on Sun Microsystems’s technology and refined the use of it which Sun Microsystems not had been able to do themselves. Y-Tech has just recently started to look for a partner to cooperate with in sales in order to increase their market shares.

Resource configuration: Their specialized and high-tech business concepts required significant investments in product development and refinement, normally spanning over several years. This has implicated a considerable need for (external) funding to finance staff/man-hours, product material and production equipment (e.g. computers, servers, software). Due to their limited creditability and track record, all spin-off firms have had to put a lot of effort in finding external funding. This was especially evident in Z-Tech, whose founders were young students, whereas the founders of X-Tech and Y-Tech with their longer experience had a higher creditability. In order to acquire external funding, the academic spin-off companies early on founded a limited company. Moreover, all spin-off ventures were started by two to four founders where different competences could be seen as complementary in the new venture. Functions such as marketing, accounting, administration and responsibility for the firm’s retailers were hence shared between the founders. X-Tech and Y-Tech have both after the venture start-up hired four to six external members of the staff for product development work. When these new ventures after some time hired also a professional board of directors they got access to a valuable function for management support – a mentoring support they would actually have needed already from the beginning but could not afford to pay for. Through their professional board of directors, the founders now got access to strategic guidance and business advice from experienced persons who knew the business and could broaden their networks and personal relations. Z-Tech have not yet been in the position of hiring a professional board of directors, but they meanwhile have got in touch with people who are willing to give some advice.

Growth and profit: Due to their large product development and personnel costs, it took several years before X-Tech and Y-Tech could report any net profits, and Z-Tech has not yet got the funding or reached the market shares and sales needed. During the post-entry development (the three to five years from start-up), X-Tech grew significantly from employing its four founders to 23 employees as a result of increased funding and a new leadership (but after five years they were down to 15 employees). The venture’s annual turnover has during this period of time increased from 530 to 640 thousand EUR, and has increased further to almost 1,1 MEUR in the year of 2005. Y-Tech has also increased their turnover into nearly half a million EUR in the year of 2004 and an employment of four persons, whereas Z-Tech has no employees and has increased its turnover from 159 thousand EUR to 213 thousand EUR. It should be noted, however, that Z-Tech has not been in operation for more than three years while the other firms in this group has run their ventures for seven and six years respectively.

Generic ventures

Product characteristics: The business concept in all companies originates from the founders’ recognition of a market opportunity signaling an unfilled market need. This need was exploited by offering the market already known products and by using the founders’ previous knowledge, experience or interest. Two of the ventures, A-Trade and B-Trade, sold products from suppliers. The third venture, C-Trade, designed own products in order to improve or reform already known products, which then in turn were manufactured and sold by other companies that the founder got into contact with through the founder’s personal network that
she built up over time and through her relations with a community support program for new ventures.

*Market characteristics and entry strategies:* The ventures’ products were offered to a general and often local or national market providing sufficient revenues in line with the ambition of the founders to make a living. In one of the firms (A-Trade), however, the initial business concept was developed and the ambitions expanded when the company through its customers and via different computer forums at the Internet learned that there was a need for a specific new software product, enabling the firm to sell also outside the national market through a web-based shop. In order to reach a larger market, C-Trade started to cooperate with a retailer in the national capital a couple of years after the start-up.

*Resource configuration:* Contrary to the academic spin-off companies, the requirements on investments were limited. This enabled the generic firms to start their companies based on their own personal savings and with the support given by government subsidies to people starting a new company of their own. Moreover, all generic companies were started by single founders. The limited need for external funding and the fact that all companies started out as solo-entrepreneurs (Hult & Ramström, 2000) implicated a simple structure where all companies started as (and still are) private firms and not limited companies. This also means that the firms have no management support in terms of a professional board of directors. All founders perceive themselves to be the most important resource for their new venture, but have to various degrees also acquired or accessed external resources and expertise to the firm. Only the founder of B-Trade had a high creditability and track record due to his prior occupation and enterprising within the line of business and did therefore not have any difficulties to get external funding and trust from suppliers and banks. B-Trade’s founder also had an established network that helped him with problem-solving, and C-Trade’s founder established a valuable network during the start-up process. A-Trade and B-Trade hired external members of the staff after their start-up to work with sales and other tasks, whereas C-Trade still operates alone.

*Growth and profit:* Based on the fact that all generic firms offered products well-known to the market and that only limited initial investments were required, these ventures could attain a net profit from their first year of operation. While B-Trade and C-Trade have consolidated their companies on a level that provides revenues enough for a decent living, A-Trade stands out as an expansive exception: during the post-entry development (the three to five years from start-up) the annual turnover of A-Trade has increased form 0,27 MEUR to 1,4 MEUR as a consequence of the changed and developed business concept. Due to the increased sales, and because of the benefits a limited company may offer, the founder now considers reforming the venture into a joint-stock company. Although both B-Trade and C-Trade also have increased their turnover, B-Trade increased their turnover by 20 % into 0,53 MEUR and C-Trade has doubled their turnover into 10,6 thousand EUR, they are in this specific respect not nearby the level of A-Trade’s development.

**Concluding discussion and further research**

Table 2 summarizes the study’s findings, depicting that academic spin-offs and generic ventures have different start-up processes, characteristics and outcomes. These findings will below be further discussed.
Table 2. The start-up processes of generic ventures and academic spin-offs

<table>
<thead>
<tr>
<th>Start-up category</th>
<th>Academic Spin-Offs</th>
<th>Generic Ventures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product characteristics</strong></td>
<td>• High-tech/knowledge-based</td>
<td>• Low-tech-based</td>
</tr>
<tr>
<td></td>
<td>• New to the market</td>
<td>• Known to the market</td>
</tr>
<tr>
<td><strong>Market characteristics</strong></td>
<td>• Technology push</td>
<td>• Market pull</td>
</tr>
<tr>
<td></td>
<td>• Specific market niche requiring a broad market</td>
<td>• General market, often addressed with geographic specialization</td>
</tr>
<tr>
<td></td>
<td>• International/global market</td>
<td>• Local/regional market</td>
</tr>
<tr>
<td><strong>Entry strategies</strong></td>
<td>• Collaboration as means of international market entry</td>
<td>• Normally relying on own resources</td>
</tr>
<tr>
<td></td>
<td>• Proactive including education of new customers</td>
<td>• Reactive; “filling a hole on the market”</td>
</tr>
<tr>
<td><strong>Resource configuration</strong></td>
<td>• Substantial need for external funding</td>
<td>• No or limited need for external funding</td>
</tr>
<tr>
<td></td>
<td>More advanced structure:</td>
<td>Simple structure:</td>
</tr>
<tr>
<td></td>
<td>• professional board of directors,</td>
<td>• one owner-manager,</td>
</tr>
<tr>
<td></td>
<td>• limited company organization,</td>
<td>• no professional board of directors,</td>
</tr>
<tr>
<td></td>
<td>• several founders</td>
<td>• private firm organization</td>
</tr>
<tr>
<td></td>
<td>• a specialized management team and hired experts</td>
<td></td>
</tr>
<tr>
<td><strong>Growth and profit</strong></td>
<td>• Planned growth and long pay-off period, implicating an increasing demand for</td>
<td>• Early growth stabilizing the firm as a “bread-and-butter-company” or emergent</td>
</tr>
<tr>
<td></td>
<td>financial and other resources</td>
<td>growth as a result of opportunity recognition</td>
</tr>
<tr>
<td></td>
<td>• No profit during the first years of operation</td>
<td>• Net profit from year one</td>
</tr>
</tbody>
</table>

As already stated, the academic spin-offs’ innovative products origin from university research whereas the generic ventures’ products were known to the market. This difference align with Schumpeter’s (1934) and Kirzner’s (1973) arguments of how entrepreneurs discover and exploit business opportunities, where the academic spin-offs enters a market through innovations that requires change of customer behavior (Walsh, Kirchhoff & Newbert, 2002), while the generic firms enter by satisfying existing market demands with, for example, replacements or substitutes for existing products. While the academic spin-off may be understood to follow a market entry strategy characterized as “technology push” (implying e.g. higher investments, international markets already from the start, a need for education of customers and longer pay-off periods), the generic firm start-ups in this study through “market pull” satisfying an existing market need with more or less well-known products and services. From this perspective the entrepreneurs with their roots in academic research manifest more of a proactive “Schumpeterian entrepreneurship” while the entrepreneurs starting what we in this paper have labeled generic firms reflect more of a reactive and “Kirznerian mode of entrepreneurship”. As the case A-Trade demonstrates, however, the start-up process itself involves learning and opens new windows of opportunities, enabling for firms to redefine their business concept along the way and where mere opportunity exploitation based on offering customers already existing solutions to their needs is combined with at least some degree of innovative product development. However, when A-Trade after the start-up changed its business idea and offered “a new for the market product” to a specific
market niche, this innovative product was initiated by the founding entrepreneur not based on “technology push” but on “market pull” – by recognizing an opportunity on the market that current products did not satisfy.

Whether the new venture has its origin in “technology push” or “market pull” also has implications for how the new venture configures its resources in order to enter its target markets. Knowledge-intensive and often high-tech companies generally require more resources for product development and (international) marketing, implying a need for external funding, long-term investments and a more advanced structure of the firm itself. Generic firms, normally targeting a regional or local “market hole” with products and services already known to the customer, may rely on own resources, a shorter time to market and pay-off, and a more simple structure of the firm. This was in this study manifested by all academic spin-offs choosing to start a limited company with a management team (many founders) and a professional board of directors in order to achieve the funding required and to access important knowledge resources, while the generic firms relied on the owner-manager him/herself and a more simple firm structure. As pointed out by e.g. Sexton & Kasarda (1992) and Storey (1994), access to different types of knowledge and expertise is important during the start-up process. If the new venture develops and exploits new and knowledge-based products/services, the importance of building a management/expert team with complementary knowledge in different functions and roles is even more highlighted (cf. Lindholm Dahlstrand 2004 and Klofsten 1998), since one person alone seldom possesses all the competencies required. Organizing a professional board of directors is from this perspective a gateway to a broader range of expertise a new venture may access; in this study employed only by the more knowledge-based firms represented by academic spin-offs.

To build networks and alliances may hence be regarded as means of extending the boundaries of the firm itself, thereby making external resources accessible to the firm. In this study, alliance building was an essential ingredient in the spin-off firms’ strategy for entering their international target markets (cf. Hitt, Ireland, Camp & Sexton, 2002). X-Tech thus engaged two retailers in the US that knew the specific demands of their target market, while Y-Tech was looking for collaboration with a sales company to help them reach a larger market. Z-Tech early on initiated cooperation with a large corporation (Sun Microsystems) in order to get attention from their desired customer segment and to be able to demonstrate the benefits of their products. Such activities were considerably lower among the generic firms since they targeted a local or regional market and relied more on their own in-house resources.

The growth of a firm may be regarded as both an input and an output of a start-up process: *input* in terms of what motives and ambitions the founding entrepreneur has for starting the new company, *output* in terms of the factual growth of the new venture. From the literature in the field (e.g. Westerberg 1998, Davidsson 1989) we know that the entrepreneurs’ own motives and ambitions are crucial as input-factors for whether the new venture will grow or not (output). In this study, all academic spin-offs already from start aimed for world leadership in their specific niche - and to earn money. The generic firms, on the other hand, were started as means of generating an income for the founder him/herself. When studying the firms’ growth processes, it was also obvious that the academic spin-offs followed a more growth-oriented and planned trajectory, whereas the generic ventures seemed to be satisfied with a so called “bread-and-butter-company”. One exception among the generic ventures already noted is A-Trade that has experienced a high growth rate since the venture after the start-up developed its business idea into a more growth-oriented trajectory. Talking to
Mintzberg and Waters (1985), this may be understood as “an emergent strategy” based on the learning the entrepreneur experienced during his start-up.

Despite the fact that the academic spin-offs in this study all clearly expressed their ambitions towards world leadership and earning (a lot of) money, it is only the generic firms that yet can report net profits. The academic spin-offs’ innovative products, which they offer to an international niche and often immature market, require significantly more investments than market offerings from generic firms (cf. Lindholm Dahlstrand, 2004). As a consequence, academic spin-offs’ normally invite external funding into a joint-stock company (which generic firms often avoid), and often reach profitability later than generic firms (which often require net revenues already from the first year). In the search for “first mover advantage” (Lee, Lee & Pennings, 2001; Grimm & Smith, 1997), timing is however essential. For new innovative products to succeed on the market, the market should “be ready” or at least with small efforts (e.g. through education) be possible to influence in order to build a market demand. According to Shane (2001), innovations and a first-mover-strategy can be an advantage for a venture, while others (e.g. Cooper and Kleinschmidt, 1993) have pointed out that inappropriate timing may act as a barrier to the market as well. Whether the investments made in the academic spin-off companies in this study will pay off and be more profitable than in the generic firms is however an issue for further study.

The main ambition of this paper has been to analyze and compare the start-up process of two different categories of firms: academic spin-offs requiring specific and high-level knowledge versus the process of starting a normal, generic new company (requiring a lower level of specialized expertise). A main question we have tried to answer is how different product and market characteristics may be understood to relate to different market entry strategies and different modes of acquiring and organizing the firm’s resources during the start-up process as well as to different consequences in terms of firm growth and revenues. The findings concluded in Figure 3 depict two very different start-up processes, and may serve as a base for drawing interesting implications for practice, policy-makers and academic research. For entrepreneurs interested in starting a new venture, this paper highlights challenges to be solved during the start-up process and how these relate to the nature of the business concept (especially the degree of knowledge inbuilt in the venture’s products and services). For policy-makers and organizations active in supporting new venture creation, this paper has hopefully manifested the dangers of generalizing business start-up as a uniformed process. In fact, entrepreneurs and business concepts are different (Bygrave 1989) and benefits from different kinds and degrees of assistance during their start-up process. For the academic community, this paper should have contributed with more in-depth knowledge on factors and processes involved when comparing knowledge-intensive new ventures with more “normal” business start-ups. A contribution is also the new questions that may be raised on the basis of this study’s findings. Adopting a learning perspective, it would for example be interesting to more thoroughly study the “experiential learning” taking place during the process of discovering, planning and exploiting a business opportunity. Related to this is the function of previous learning and experiences: Do “habitual entrepreneurs” behave differently than “first time entrepreneurs”? Following the holistic approach taken in this paper, it should also be important to try to get a more full understanding of the new venture creation process, involving e.g. entrepreneurial motivation and individual capabilities as factors taken more into consideration. Recognizing the limited number of cases studied here, an obvious route for further research would be to utilize more robust empirical data, facilitating also more of statistical generalization.
References


Socioeconomic Networks:
In Search of Better Support for University Spin-offs

Danny P Soetanto
Marina van Geenhuizen
Faculty of Technology, Policy and Management
Delft University of Technology
PO Box 5015, 2600 GA Delft, The Netherlands
Contact: d.p.soetanto@tbm.tudelft.nl

Abstract

In this paper, we explore factors that may determine the performance of university spin-off companies. In particular, we focus on socioeconomic networks and support received from incubator organizations. Using spin-offs from the Technical University of Delft, the Netherlands as a case study, we explore whether spin-offs’ performance is influenced by the characteristics of their networks, i.e. tightness, strength of relationships, heterogeneity in partners’ background and spatial proximity. With regard to support from incubator organizations, we distinguish between conventional and added value support and explore whether spin-offs perform better if they receive both types of support compared with only conventional support. The results of the regression analysis confirm that loose networks and weak relationships are enhancing spin-offs’ growth. It was also confirmed that interaction with partners of diverse backgrounds enhances growth, while a positive influence of close geographical proximity with network partners was not confirmed. In addition, the results confirmed the idea that receiving a combination of conventional and added value support has a more positive influence on spin-offs’ growth than receiving only conventional support. Overall, network characteristics tend to influence growth much stronger than various support measures.

Keywords: university spin-offs, resources, network, regression analysis, TU Delft (The Netherlands).
1. Introduction

Over the last two decades, there has been an increased attention for the contribution of universities and other public research institutions to the creation of new ventures. University spin-offs (USOs) transfer scientific and technological knowledge from universities to the market place (Chiesa and Piccaluga, 2001). University spin-offs may appear small in terms of aggregate employment, but they significantly contribute to the creation of new jobs and innovation of the regional economy (Rothwell and Zegveld, 1985, Mansfield, 1991). Having new technology as the core of their business and provided that they are clustered in space, these firms increase the competitive edge of regions (e.g. Keeble and Wilkinson, 1999). In more detail, USOs offer benefits such as:

- To promote technological entrepreneurship in regions as they base their business mostly on high technology development, rely on high-tech skills, and pay good wages.
- To stimulate other business support and infrastructures that in turn provide benefits to other start ups (Lockett et al. 2003).
- In the context of the university, to strengthen the relationships with the business community, improve the image of universities, fulfill commitment to society, and generate income from patents (e.g. Heydebreck et al., 2002)

Over the years, these advantages have been widely recognized and fostering spin-offs has become part of most universities’ and research centers’ policy to commercialize research results. Among the many ways to accelerate the growth of USOs, perhaps the most captivating one is establishing incubator organizations. The infrastructure of incubators was built gradually in industrial countries such as the United States and Western Europe in the last two decades. Incubators have evolved and now appear to reach maturity (Lalkaka, 2001). The first generation of incubators in the 1980s essentially only offered affordable office facilities to potential new firms. As time progressed, it was realized that the needs of spin-offs include more than just physical support (e.g. office and administrative support) and financial support. This situation has challenged various incubators to respond to the necessity of providing “value added support”, like business skills training and connecting the entrepreneur with different networks.

However, after several years of spin-offs euphoria, some studies have started to look critically at the entrepreneurial output of universities. A recent study points out that even though some successful spin-out companies have been created, the mechanism has been overemphasized and it is still doubted that spin-offs will survive in the long term (Lambert, 2003). Other studies have also examined the impact and high transaction cost of spinning out in a critical way (Bozeman, 2000; Lerner, 2005). In spite of these critics, the creation of university spin-offs still represents a potentially important innovation mechanism for academia (Vohora et al. 2004). It seems necessary to shift the support policy to the creation of better performing spin-offs. This means focusing on the quality of spin-offs instead of the quantity (Clarysee et al., 2004). Consequently, incubator organizations need to reconsider their support.

We look at the growth of USOs as a process in which USOs try to acquire vital resources for their survival. However, in reality resources available to USOs are often not sufficient. Some USOs receive support from incubator organizations even though not all resources can be covered, while other USOs have to strive for acquiring resources on their own. Thus, the chance to grow depends critically on the environment of spin-offs and on the nature of the interaction with ‘external partners’ including friends, family, colleagues, and former lecturers or professors that provide access to important resources (Birley, 1985). In this respect,
networks as an essential factor influencing the survival of USOs should receive considerable thought from incubator organizations. Unfortunately, little attention has been paid to ways to improve the network structures of USOs. Although networking is seen by various authors as a key feature in explaining the nature of newly established firms and in predicting their future success (Larson and Starr, 1993), very few studies (except for Perez and Sanchez, 2003) focus on the early years of USOs’ networks development. Moreover, with some exceptions (e.g. Nicolaou and Birley, 2003) relatively few empirical studies have attempted to use statistical analysis. Most research on USOs’ networks draws on case studies. Thus, so far the influence of socioeconomic networks that may determine early growth of spin-offs are still unexplored by using large and medium scale surveys (Markman et al., 2005).

This study is undertaken in response to the lack of attention given to factors underlying the growth of USOs. We address the following question, what are the influence different socioeconomic networks and different support received from incubator organization on the growth of USOs? Following Cooper (1992), our approach uses multi-factors as a predictor for firm performance, instead of focusing only on one particular factor, because the former approach is more comprehensive in predicting the USOs’ performance. Accordingly, we develop a causal model and test this model by applying regression analysis. The paper is presented in the following structure. First, we provide a brief overview of Resource-Based theory followed by the development of hypotheses. In the next section, the research design is discussed. The regression results and evaluation of these results follow in the section. The paper ends with brief discussion of policy implications.

2. **Theoretical Background: Resource-Based Theory**

In general, to understand factors that explain the growth of firms, scholars have developed various theoretical viewpoints, including knowledge-based theory, the dynamic capability perspective, business networks, and strategic alliances. Basically, all of these approaches are rooted in the Resource Based View (RBV) introduced by Penrose (1959). Penrose’s seminal work has been instrumental to the on-going development of modern resource-based theory that is applied in many fields such as strategic management, organization studies and marketing.

According to the RBV, firms are conceptualized as heterogeneous bundles of assets or resources tied to the firms’ management. Firms acquire or search for resources as an input and convert these into products or services for which revenue can be obtained. The resource based view suggests that heterogeneity of resources is necessary but not sufficient for a sustainable advantage. It suggests that resources have to be unique to firms in order to create competitive advantage. Resources should also be difficult to imitate, otherwise, competitors can easily obtain these resources and neutralize the competitive advantage (Barney, 1991).

In reality, firms frequently lack critical resources during their early development. Apart from the lack of basic resources such as initial investment and office facilities, new and small firms may also desire what are called added value resources such as the ability to identify business opportunities, learning to manage the firm, business guidance or advice, and mental endorsement. Such resources can be acquired; e.g. through the networks of these firms (Pisano, 1990).

Organizations, whether established firms or start-ups, are part of a network and are dependent on external actors (Pfeffer and Salancik, 1978). Studies on small firm growth indicate that
developed networks of strong relationships with various partners may be an advantage to gain resources (Hoang and Antoncic, 2003). Networks provide entrepreneurs with avenues for negotiation and persuasion, enabling them to gather a variety of resources (e.g., market information, problem solving, social support, venture funding, and other financial resources) held by other actors (Nicolaou and Birley, 2003). Birley (1985) observes the extensive use of social networks in the early stages of a venture generation process. Starr and MacMillan (1990) document the use of social and economic exchange mechanisms to acquire resources and to gain legitimacy during the early stages of ventures.

The literature (e.g. Birley, 1985) tends to distinguish between two types of networks on which firms can draw: formal and informal. Formal networks include financial institutions, accountants, lawyers, the chamber of commerce, small business administrators, etc. These are the people/institution who are directly connected with business matters. Informal networks may include family, friends, previous colleagues or previous employers, and former professors or lecturers. Conversations with them may range from hobby, family to business. Some of the relationships have been established long before entrepreneur launched their business. However, such networks are not static but dynamic from time to time. For instance, informal networks with friends may become formal ones when friends turn into customers. Moreover, there is no clear boundary between formal and informal. A person can be a tax consultant and friend at the same time.

In this study networks are defined as a socioeconomic network of important ‘partners’ that potentially provide valuable resources for firm growth. As USOs frequently lack critical resources during their early development, especially entrepreneurial knowledge and skills (Geenhuizen and Soetanto, 2003). Accordingly, USOs may attempt to manage obstacles by seeking a solution through their ‘partners’ (e.g. friends, colleagues, former professor, etc). These relationships with ‘partners’ are may be essential in order to gather relevant knowledge, to get external support and service, to access external resources not available in-house, and to look for business advice (Birley, 1985). Thus, in the early years of USOs’ establishment, socioeconomic networks may be important and cannot be neglected.

Another possibility for gaining resources is through incubator organizations. As an organization, incubators aim to accelerate the development of start-ups by providing an array of targeted resources and services. Incubators traditionally merge the concept of fostering new business development with the concept of technology transfer and commercialization (Phillips, 2002). They can be seen as entrepreneurial (non-profit) organizations in performing a bridging function between promising spin-offs and resources required by these spin-offs while protecting them against any potential failure (Hackett and Dilts, 2004). Incubators may also act as a link between start-ups and other partners that provide resources, such as venture capitalists, governments, financial institutions, and other business practitioners. In fact, incubators perform as a mechanism for a wide range of networking while encouraging the development of small businesses.

Many incubators employ large buildings, in which they offer customized rooms and supporting services. However, there are also examples of decentralized facilities, e.g. rooms spreading over different faculty buildings of universities. Generally, incubators support start-ups only on a temporary basis, e.g. three or four years, after which the start-ups are forced to leave the incubator and support will end. Some incubator organizations also try to provide access to business networks such as trade organizations. USOs can make use of these types of
support below market price, and thus they enjoy a cost reduction and enhance their competitive advantage.

3. Model Development and Hypotheses

The central proposition of resource-based theory is that a firm has to build on and maintain their set of resources in order to survive and stay competitive. As the resources do not reside exclusively within firms, we argue that there are two ways that USOs can use to gain their resources that are through (1) socio-economic network and (2) incubators’ support. The following sections will discuss each of the two factors and will present various hypotheses built base on them.

3.1 Socioeconomic Network

Although many empirical studies have proven benefits of socioeconomic networks for firm growth, little is known about the mechanism or structures inside socioeconomic networks between USOs and their partners. In reality, not all firms possess comparable levels of network resources. Firms’ socioeconomic networks vary in terms of structure, pattern of relationship, and the variation in the mix of contacts. Therefore, the first part of our model serves to investigate the contribution of this factor in USOs’ growth. In our study socioeconomic networks are examined by focusing on network characteristics: structural, strength of relationship, social, and spatial characteristics. The structural dimension refers to the degree of tightness among partner networks of USOs. The strength of relationship refers to the length of time and emotion invested on relationships. A social characteristic refers to the difference of social status among partners in networks. A spatial characteristic refers to the geographical location of partners.

3.1.1 Structural Characteristics: Tight or Loose Networks

In the literature of small business development, the importance of dense or tight networks is emphasized as being one of the factors influencing the survival of new and small firms. Tight networks are described as networks where everyone is connected to each other. Because people know and interact with each other, they are more likely to convey and reinforce norms of exchange and more easily able to monitor their observance and enforce sanctions. In business, such networks will reduce risk and enhance the opportunity to build cooperation and get access to resources from other people connected in the network. People on this kind of network are familiar with each other’s interest, making the transfer of knowledge less difficult. They also build trust and credibility on each other. Therefore, tight networks are beneficial for the transfer of complex and tacit knowledge, development of trust and comfort, legitimacy or reputation, and joint problem solving (Coleman, 1990; Uzzi, 1996).

In contrast with the above argument, Granovetter (1992) suggests that people who are connected in sparsely networks will enjoy more advantages. Accordingly, a loose networks structure causes benefits from the diversity of information and the brokerage opportunities created by the lack of connection between separate clusters in social networks. This leads into a concept called Structural Hole Theory (by Burt, 1992). The persons who occupy brokerage positions between those clusters have better access to information. Structural holes separate non redundant sources of information, sources that are more additive than overlapping. By being connected in a network which is rich of new information and opportunities, entrepreneurs have benefits in terms of: (1) enhancing business opportunities, (2) getting access to resources that could not otherwise be obtained, which often constitute the linking
knot between seemingly unrelated resources, (3) getting references from partners that may lead entrepreneurs to a new business network.

Studies of the role of structural characteristics of networks on the performance of new firms are not conclusive. Several studies have stressed that linkages with tight networks are more advantageous for the early growth of firms (Gulati, 1995), while others emphasize the importance of being connected to loose networks (McEvily and Zaheer, 1999). This consideration leads to our first hypotheses:

**Hypothesis 1a** The performance of USOs is positively affected by tight networks.

**Hypothesis 1b** The performance of USOs is positively affected by loose networks.

### 3.1.2 Strength of Relationships: Strong or Weak Relationships

Whereas the above characteristics, tightness refers to structure of the networks. Strength of the relationship refers to the quality of relationship. The strength of relationships between USOs and their partners varies based on the time invested in the relationships. Usually, strong relationships are based on long-term and intense interactions. Typical examples of strong relationships include friendship and family ties. However, Granovetter (1995) defines the strength of relationships based on time and emotions invested in a relationship, as well as the reciprocity involved between participating actors. As people know each other more and become emotionally involved, they will develop a relationship in which they put their trust, commitment and willingness to support each other reciprocally. This type of relationship is important for entrepreneurs that try to market an unproven product and have limited resources. In such situations characterized by a high level of uncertainty, entrepreneurs will heavily rely on close friends or family members for learning, protection and support.

The concept of social networks presents a contradictory argument. Although initially developed by sociologists, this concept has been increasingly used to explain economic actions (e.g Larson and Starr, 1993). Granovetter (1973) argues that new information is obtained through casual acquaintances rather than through strong personal relationships. Since the strongly connected actors are likely to interact frequently, much of information that circulates in this social system is the same. Conversely, **weak ties** often include links with actors who move in social circles other than those of the focal actors. It is suggested that weak ties are an important source of information about activities, resources, and opportunities in distant parts of social system. Weak ties are often more important in spreading information or resources because they tend to serve as a bridge between otherwise disconnected social networks. In attempts to obtain resources for growth, weak ties may be essential for USOs. It is through weak ties that USOs can recognize novel information which leads them to new resources and enabling to exploit a new business opportunities. Because of the contradiction the above argument, we formulate the following hypotheses:

**Hypothesis 2a** The performance of USOs is positively affected by strong relationships.

**Hypothesis 2b** The performance of USOs is positively affected by weak relationships.

### 3.1.3 Social Characteristics: Heterogeneity of Contact Background

The third hypothesis is about the social characteristics of networks. Marsden (1987) shows that diverse partners integrating several spheres of society often facilitate more beneficial actions to individuals than similar partners. With regards to USOs’ development, partners that come from a different environment of USOs have more variety in their perceptions and give access to a wider range of resources. The more heterogenous partners USOs have, the more
variety of resources such as know-how, information and expertise to USOs can access. Hence, heterogeneity of partners’ backgrounds increases the likelihood of obtaining valuable information, knowledge, and guides spin-offs to different resources. Therefore, we hypothesize as follows:

Hypothesis 3 The performance of USOs is positively affected by a large heterogeneity of partners’ backgrounds.

3.1.4 Spatial Dimension: Geographical Proximity
In the study of network creation, it is assumed that networks do not randomly link individuals. Rather, people interact most frequently with those in close geographical proximity and with whom they share common backgrounds, interests and affiliations (Gertler, 2003). Because both physical and social locations strongly influence people’s activities, proximity on these dimensions increases the likelihood of interaction and communication (Blau, 1977). More specifically, spatial proximity decreases direct costs associated with frequent and extended interaction necessary for maintaining social relationships (Zipf, 1949), particularly close personal networks. As the geographical distance between spin-offs and their partners increases, the opportunity for meeting in person and face-to-face interaction is lower and it is more difficult to maintain an effective relationship. In contrast, a network of partners that is clustered provides a greater opportunity to interact actively with partners and to benefit from knowledge spillovers (e.g. Audretsch, 1998; Camagni, 1991). Accordingly, we argue that a close spatial proximity between USOs and their partners will have a positive influence on USOs’ performance.

Hypothesis 4 The performance of USOs is positively affected by a close spatial proximity to network partners.

3.2 Support from Incubation Organizations
The last hypothesis is related with the nature of support provided by incubator organizations. The nature of support may vary considerably, dependent upon the perceived needs of start-ups and the competence and resources of incubators. Conventional support is oriented towards the provision of ‘basic resources’, e.g. office, administration and financial support. However, there has been an important evolution in the kinds of support, from conventional to added value support; the latter includes support such as entrepreneurial courses for enhancing business skills, business mentoring and networking services. Overall, the types of support provided by incubator organizations can be grouped into two following categories:

1. Conventional support (e.g loan, grant, venture capital, office facilities, shared administration facilities)
2. Added value support (e.g. business counseling, consultation, entrepreneurial training, networking possibility, equipment and research facilities)

In this study, we assume that conventional support only fulfill a basic need of USOs. It may help USOs to overcome their first obstacles in terms of initial investment and office. However, for further development, USOs may need more added value support as well. Therefore, we propose the following hypothesis:

Hypothesis 5 USOs which receive conventional support plus value-added support perform better than USOs that receive only conventional support.
Related with socioeconomic networks of USOs, we assume that added value support; especially support such as in searching for partners, will moderate the relationship between socioeconomic networks and performance. Therefore, we hypothesize as follows:

**Hypothesis 6** The performance of USOs is positively affected by the interaction effect between socioeconomic networks and network building support.

![Figure 1. Determinant factors of USOs’ performance](image)

4. **Research Design**

The study draws on a survey of university spin-offs of TU Delft, the Netherlands. In total the population includes 61 spin-offs, defined by two criteria, that is age not older than 10 years and having received support at least one type of support from TU Delft. The response rate was 67% leading to 41 valid interviews.

In this study, an Ordinary Least Square (OLS) regression analysis was used (see appendix for the explanation of the variables). To test the hypotheses, five models were estimated. Model 1 tested the hypotheses about socio-economic networks of the USOs. The impact of support was tested in model 2 and 3. Model 2 include a single variable explaining whether the USOs received only conventional support and/or added value support. In the next model (model 3), we examined the roles of each type of support in determining the USOs’ performance. Moreover, we also conducted a regression analysis by combining the factors of the socioeconomic network and support from incubators in one model (model 4 and 5).

In the next step, the moderating influence of one single support measurement, i.e. support in network building, was tested.

A moderated hierarchical regression analysis was utilized following the method described by Cohen and Cohen (1983). According to their method, the change in $R^2$ was evaluated as an indicator for model significance. In the first step, the characteristics of the socioeconomic networks were entered, in the second step the support variable was added, and this was
followed in the third step by add the interaction effect between the support and each of the characteristics of socio-economic networks.

One of the pitfalls in estimating regression models is the existence of multicollinearity among independent variables. To check for multicollinearity, the so-called variance inflation factor (VIF) was used, which is the reciprocal of tolerance. Large VIFs are an indication for the presence of multicollinearity. The VIFs found in the estimates ranged from 1.24 to 1.58, meaning that no multicollinearity problems occurred.

5. Empirical results

5.1 Descriptive statistics

In this section we provide descriptive statistics. Table 1 shows a brief description of our sample. The number of firms in each age category has the same proportion. TU Delft’s spin-offs are relatively small firms, most of them have less than 5 employees (44%) and almost one third have between 5 and 10 employees (37%). Most of the spin-offs can be seen as strongly innovative. They have in-house R&D (92%) and invest quite a large amount in R&D. Around 70% of the spin-offs spend more than 10 percent of annual turnover in this activity. The USOs produce turn over from different sources, including selling products, consultation, and development and design. In some cases, the spin-offs have more than one source of income.

Table 1. Descriptive Statistics of sample

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Absolute</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Less than 4 years old</td>
<td>14</td>
<td>34.15</td>
</tr>
<tr>
<td>- 4-6 years</td>
<td>14</td>
<td>34.15</td>
</tr>
<tr>
<td>- More than 6 years</td>
<td>13</td>
<td>31.71</td>
</tr>
<tr>
<td>Size (fte)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Less than 5 fte</td>
<td>18</td>
<td>43.90</td>
</tr>
<tr>
<td>- 5-10 fte</td>
<td>15</td>
<td>36.59</td>
</tr>
<tr>
<td>- More than 10 fte</td>
<td>8</td>
<td>19.51</td>
</tr>
<tr>
<td>In-house research and development</td>
<td>38</td>
<td>92.00</td>
</tr>
<tr>
<td>R&amp;D (per cent of annual turnover)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- None</td>
<td>5</td>
<td>12.20</td>
</tr>
<tr>
<td>- Less than 10 per cent</td>
<td>7</td>
<td>17.07</td>
</tr>
<tr>
<td>- 10-30 per cent</td>
<td>18</td>
<td>43.90</td>
</tr>
<tr>
<td>- More than 30 per cent</td>
<td>11</td>
<td>26.83</td>
</tr>
<tr>
<td>Source of turnover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Product sale</td>
<td>22</td>
<td>31.43</td>
</tr>
<tr>
<td>- Consultation</td>
<td>24</td>
<td>34.29</td>
</tr>
<tr>
<td>- Development and design</td>
<td>24</td>
<td>34.29</td>
</tr>
</tbody>
</table>

Note: * more than one category possible per firm.

Table 2 shows obstacles faced by the USOs during their development. It appears that knowledge (skills) is the most problematic need, especially marketing knowledge and sales skills. Dealing with future uncertainty together with a lack of capability in forecasting future markets is one of the problems faced by most of the USOs. Next important is a shortage in skills to handle management overload. Half of the spin-offs also report that they face financial problems. Other issues, such as accommodation and the availability of research infrastructure appear to be of minor importance. The previous findings are similar with the findings of a study of problematic needs experienced by TU Delft spin-offs in 2002 (Van Geenhuizen and Soetanto, 2003)
Table 2. Problematic obstacles

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Specification</th>
<th>Total</th>
<th>%</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market-related knowledge</td>
<td>Lack of marketing knowledge</td>
<td>22</td>
<td>15.71</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Lack of sales skills</td>
<td>20</td>
<td>14.29</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Lack of forecasting capability about future markets</td>
<td>18</td>
<td>12.86</td>
<td>4</td>
</tr>
<tr>
<td>Management-skills</td>
<td>Difficulty in dealing with uncertainty</td>
<td>19</td>
<td>13.57</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Too many managerial tasks to handle</td>
<td>12</td>
<td>8.57</td>
<td>5</td>
</tr>
<tr>
<td>Market</td>
<td>Lack of market demand</td>
<td>10</td>
<td>7.14</td>
<td>6</td>
</tr>
<tr>
<td>Financial</td>
<td>Lack of investment capital</td>
<td>9</td>
<td>6.43</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Lack of cash flow</td>
<td>6</td>
<td>4.29</td>
<td>8</td>
</tr>
<tr>
<td>Physical</td>
<td>Lack of adequate accommodation</td>
<td>5</td>
<td>3.57</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Lack of research and testing facilities</td>
<td>4</td>
<td>2.86</td>
<td>10</td>
</tr>
</tbody>
</table>

*Note: more than one obstacle possible per firm.*

It is not surprising that shortages in market- and management-related knowledge and skills are the major obstacles, since USOs evolve from an initial idea in a non-commercial environment to a competitive profit generating firm, a stage in which new and completely different knowledge and routines are required (Vohora *et al.*, 2004). To overcome these obstacles, it is assumed that USOs seek external support through their socioeconomic networks.

Table 3. Descriptive statistics of variables used in analysis

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Mean</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job growth (fte, 1996-2005)</td>
<td>1.10</td>
<td>1.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Mean</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics of network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of partners (2005)</td>
<td>3.75</td>
<td>.965</td>
</tr>
<tr>
<td>Frequency of interaction with partner (2005)</td>
<td>2.28 (per month)</td>
<td>1.26 (per month)</td>
</tr>
<tr>
<td>Duration of relationship with partner</td>
<td>6.00 (year)</td>
<td>2.73 (year)</td>
</tr>
<tr>
<td>Heterogeneity index</td>
<td>0.58</td>
<td>0.13</td>
</tr>
<tr>
<td>Spatial proximity of partners</td>
<td>20.11 (minutes by car)</td>
<td>7.39 (minutes by car)</td>
</tr>
<tr>
<td>Type of support</td>
<td>Absolute</td>
<td>Percentage</td>
</tr>
<tr>
<td>Office and services</td>
<td>19</td>
<td>46.34%</td>
</tr>
<tr>
<td>Grant, loan or venture capital</td>
<td>21</td>
<td>51.22%</td>
</tr>
<tr>
<td>Marketing-related support</td>
<td>15</td>
<td>36.59%</td>
</tr>
<tr>
<td>Managerial consultation</td>
<td>15</td>
<td>36.59%</td>
</tr>
<tr>
<td>Network building</td>
<td>14</td>
<td>34.15%</td>
</tr>
<tr>
<td>Training/seminar</td>
<td>26</td>
<td>63.41%</td>
</tr>
<tr>
<td>Access to research results from university</td>
<td>10</td>
<td>24.39%</td>
</tr>
<tr>
<td>Access to research facilities at the university</td>
<td>16</td>
<td>39.02%</td>
</tr>
</tbody>
</table>

Table 3 shows the descriptive statistics of some network characteristics (see also appendix). We have measured network characteristics by using the name-generator technique. This technique is conducted by asking the respondent to name individuals with whom they mainly interact concerning exchange of information about business problems and opportunities and concerning other types of resources. Consistent with other studies, TU Delft’s spin-offs have 3.75 partners on average. The study by Renzulli *et al.* (2001) reported that spin-offs have an average of 4.8 external partners. McEvily and Zaheer found the number of 3.5 connected partners per spin-offs. According to the entrepreneurs, they meet their partners in face to face interactions 2.28 times per month on average. Our respondents reported that they have known the contacts for 6.00 years on average. Related with support, most of the respondents reported that they received support such as training or seminar (63.41%) and loan or grant (51.15%).
5.2 Regression analysis

In this section, we examine to what extent the previously discussed socioeconomic networks influence the growth of USOs. In addition, we examine the influence of various support measures that USOs have received from the incubator and/or directly from the university. To these purposes, a regression analysis was performed. Table 4 reports the results of five models generated in the regression analysis. We start with a discussion about the statistical significance of each variable followed by the interpretation of the sign of the regression coefficient of each variable. Next, we will discuss the results from the moderated hierarchical regression analysis. At the end of this section, we will draw conclusions on the hypotheses.

Table 4. Results of ordinary least squares regression

<table>
<thead>
<tr>
<th>Job growth as a dependent variable</th>
<th>Independent variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-economic networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightness</td>
<td>-.321**</td>
<td>-.299**</td>
<td>-.308**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength of relationship</td>
<td>-.329*</td>
<td>-.196*</td>
<td>-.293*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity in partners’ background</td>
<td>-.269**</td>
<td>-.258*</td>
<td>-.288*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial proximity (of network partners)</td>
<td>.442**</td>
<td>.405**</td>
<td>.463**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mix of support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed conventional and added value support</td>
<td>.588**</td>
<td>.190*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office and services</td>
<td>-.329**</td>
<td>-.148*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grant, loan or venture capital</td>
<td>-.300*</td>
<td>-.046*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Added value support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing-related support</td>
<td>.365**</td>
<td>.086</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial consultation</td>
<td>.022</td>
<td>.076</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network building</td>
<td>.432**</td>
<td>.059</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training/seminar</td>
<td>.048</td>
<td>.033</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to research results from university</td>
<td>.225</td>
<td>.030</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to research facilities in university</td>
<td>.073</td>
<td>-.014</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>22.64</td>
<td>13.89</td>
<td>2.34</td>
<td>20.59</td>
<td>8.41</td>
<td></td>
</tr>
<tr>
<td>Significance of F (Prob&lt;F)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.7155</td>
<td>.2626</td>
<td>.3692</td>
<td>0.7462</td>
<td>0.7829</td>
<td></td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.6839</td>
<td>.2437</td>
<td>.2114</td>
<td>0.7100</td>
<td>0.6898</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.10 * * p<0.05 *** p<0.01

All variables concerning the network characteristics are consistently significant throughout model 1, 4 and 5 and so is the variable concerning a mix of conventional and added value support in model 2 and 4. With regard to the different types of support (model 3), only four variables (e.g. office and service, grant/loan or venture capital, marketing-related support, and network building) are significant. Model 4 shows, however, that a mix of support is only marginally significant (p<0.10). In model 5, almost all support variables are not significant. Only office support is marginally significant (p<0.10). We may conclude that network characteristic variables dominate as influence on performance of USOs.

Our next discussion will focus on the direction (sign) of the regression coefficients. Model 1 presents the influence of socio-economic networks. The literature shows the ambiguous pattern of a positive relationship being either tight or loose. However, our results reveal that a loose network is essential. This implies that having partners in different networks (loose networks) tends to increase USOs’ performance. With regard to hypothesis 2, employing
weak relationships appears to be important for growth of the spin-offs. Further, the hypothesis about a positive relationship between USOs’ performance and heterogeneity of contacts’ background is confirmed. In addition, the results fail to prove the positive impact of nearby partners in determining USOs’ performance. Apparently, local knowledge spillovers have no positive impact on USOs’ growth. With regard to the kind of support (hypothesis 5), the regression results (model 2) indicate that a combination of conventional and added value support tends to enhance growth. The results point out that the more diverse the added value support received by USOs is, the better USOs’ performance is.

The regression model (model 3) reveals different findings concerning the hypothesis about the role of individual support measures. Some support such as marketing-related support and network building are found to positively influence the USOs’ performance. The two types of conventional support show a negative sign. This would mean that USOs who receive such support do not perform well. Probably, this is caused by the fact that our sample includes a relatively large share of young spin-offs that have received this support but could not grow yet because of their young age (34% - 2-4 years old). This result once more confirms that USOs which receive a combination of conventional and added value support perform better.

Table 5. Moderated hierarchical regression analysis

<table>
<thead>
<tr>
<th>Step</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Socio economic network (B, C, D, and E)</td>
<td>Network building support (A)</td>
<td>Interaction variables A x B A x C A x D A x E</td>
</tr>
<tr>
<td>R2</td>
<td>0.716</td>
<td>0.746</td>
<td>0.747</td>
</tr>
<tr>
<td>ΔR</td>
<td>0.031</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>4.237**</td>
<td>0.098</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.716</td>
<td>0.746</td>
<td>0.747</td>
</tr>
<tr>
<td>ΔR</td>
<td>0.031</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>4.237**</td>
<td>0.160</td>
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<tr>
<td>R2</td>
<td>0.716</td>
<td>0.746</td>
<td>0.783</td>
</tr>
<tr>
<td>ΔR</td>
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<td>0.037</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>4.237**</td>
<td>5.727**</td>
<td></td>
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<tr>
<td>R2</td>
<td>0.716</td>
<td>0.746</td>
<td>0.746</td>
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<tr>
<td>ΔR</td>
<td>0.031</td>
<td>0.000</td>
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</tr>
<tr>
<td>F</td>
<td>4.237**</td>
<td>0.026</td>
<td></td>
</tr>
</tbody>
</table>

Note: A: Network building support; B: Tightness; C: Strength of relationship; D: Heterogeneity in partners background; E: Spatial proximity

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network building support x Tightness (A x B)</td>
<td>-0.050</td>
</tr>
<tr>
<td>Network building support x Strength of relationship (A x C)</td>
<td>-0.020</td>
</tr>
<tr>
<td>Network building support x Heterogeneity in partners background (A x D)</td>
<td>-0.228**</td>
</tr>
<tr>
<td>Network building support x Spatial proximity (A x E)</td>
<td>0.010</td>
</tr>
</tbody>
</table>

* p < 0.10 * * p < 0.05 ** p < 0.01

The previous analysis suggests positive relationships between the characteristics of networks, that is loose networks, weak relationships, heterogeneous contacts and a large distance to partners and the performance of USOs. In order to identify whether network building support plays a role in moderating these relationships, we employed a two-ways moderated hierarchical regression model. The results (table 5) show that a significant influence only appears with regard to heterogeneity of the partners’ backgrounds. Interaction between network support and other network characteristics is not significant. Apparently, socioeconomic networks develop and grow under the influence of other factors, such as the entrepreneurs’ capability in establishing networks, location history, or relationships already
present before the companies started. We may summarize our results in terms of rejecting or accepting the hypotheses in table 6.

**Table 6. Summary of hypothesis**

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Description</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1a</td>
<td>Performance of USOs is positively affected by tight networks.</td>
<td>Rejected</td>
</tr>
<tr>
<td>Hypothesis 1b</td>
<td>Performance of USOs is positively affected by loose networks.</td>
<td>Accepted</td>
</tr>
<tr>
<td>Hypothesis 2a</td>
<td>Performance of USOs is positively affected by strong relationships.</td>
<td>Rejected</td>
</tr>
<tr>
<td>Hypothesis 2b</td>
<td>Performance of USOs is positively affected by weak relationships.</td>
<td>Accepted</td>
</tr>
<tr>
<td>Hypothesis 3</td>
<td>Performance of USOs is positively affected by strong heterogeneity of partners’ backgrounds.</td>
<td>Accepted</td>
</tr>
<tr>
<td>Hypothesis 4</td>
<td>Performance of USOs is positively affected by close spatial proximity between USOs and their partners.</td>
<td>Rejected</td>
</tr>
<tr>
<td>Hypothesis 5</td>
<td>USOs which receive conventional support plus value-added support perform better than USOs that receive only conventional support.</td>
<td>Accepted</td>
</tr>
<tr>
<td>Hypothesis 6</td>
<td>Performance of USOs is positively affected by the interaction effect between network building support and socio economic network characteristics</td>
<td>Mostly rejected</td>
</tr>
</tbody>
</table>

6. Conclusion

The aim of this paper was to explore the influence of socio-economic networks and of various supports on USOs’ performance. Our empirical findings confirmed that spin-offs that have networks rich in loose and weak relationships are in a better position to grow compared to spin-offs that employ tight and strong relationships. In addition, a large diversity in the background of partners appeared to be essential. The previous results all point into the same direction, that is, relatively open information (knowledge) sources and flow have a positive influence on growth of innovative companies. In contrast with our expectation, the findings failed to prove that a close spatial proximity of partners has a positive influence on growth. We may understand this result is so far close spatial proximity leads to network characteristics that prevent an open information and knowledge flow. However, the idea that a close proximity apparently does not lead to cost advantages, like in achieving new knowledge (knowledge spillovers), is more difficult to understand. With regard to support provided by incubator organizations and/or directly by the university, the results showed that conventional support is effective if combined with added value support. We may conclude that the overall findings confirm the ongoing discussion in the literature about the need to improve the support provided to USOs. We propose to put a greater emphasize on added value support, particularly on network building that could lead to loose and weak networks and a large diversity in partners’ background.

We believe that our case study of TU Delft’s spin-offs can be generalized to some extend, namely to technical universities and technical faculties at general universities in Western Europe, particularly in countries facing a relatively weak entrepreneurial (risk-taking) culture. However, there are two things to consider. First, from the perspective of the type of incubation policy. TU Delft’s incubation policy is specific as it represents the so-called low selective model (Clarysse et al., 2005). This model aims to create as many start-ups as possible and focuses on providing conventional support. Second, from the location perspective. TU Delft’s spin-offs are located at a close distance of two important large cities, The Hague and Rotterdam. This poly-centric pattern of cities may lead to different spatial networks compared with spin-offs located in single cities.
Despite the interesting results, we acknowledge that there are some limitations in our study. The limitations are methodological in nature. First, we were not able to exclude a certain fuzziness in the data on personal networks with regard to spin-offs managed by more than one entrepreneur. This is a common situation in network study using so-called ego-centric technique (Brewer and Webster, 1999). In addition, a certain bias has entered the measurement of openness of the networks with regard to weak relationships. It was difficult to identify whether network partners in a weak relationship interact with each other independent of the ego.

In conclusion, this study is to be viewed as a first effort to identify broad patterns of socioeconomic networks experienced by USOs and the influence of these patterns on growth. In a next step, this study can be extended by conducting research that may lead to: a more refined understanding of the role of spatial proximity of networks in influencing growth of USOs and of the interaction effect of age on other factors in determining this growth.

Acknowledgement
This study is the result of the Delft Center of Sustainable Urban Areas of Delft University of Technology.

References:


### Appendix

<table>
<thead>
<tr>
<th>Regression</th>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear regression and moderated hierarchical regression</td>
<td>Job growth</td>
<td>Measured by average annual growth in full-time equivalents.</td>
</tr>
<tr>
<td>Tightness</td>
<td>Measured by the number of existing relationship divided by the number of potential relationship. The value of this variable is between 0 and 1. A low value indicates a loose network and a high value indicates a tight network.</td>
<td></td>
</tr>
<tr>
<td>Strength of relationship</td>
<td>Measured by two criteria: the average frequency of interaction and the number of years the relationships have lasted. [=\left(\frac{\text{frequency of interaction}}{\text{partner}}\right)+\left(\frac{\text{number of years the relationship}}{\text{partners}}\right)] A low value indicates a weak relationship and a high value indicates a strong relationship.</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>Measured by the sum of the outcomes of the heterogeneity index of each type of partners’ background (e.g. academic, business). The index is calculated on the basis of the square of the number of partners from a similar background divided by the total number of partners. A high value indicates that many partners come from the same background and a low value indicates that partners have diverse background.</td>
<td></td>
</tr>
<tr>
<td>Spatial proximity</td>
<td>Measured by the average travel time to partners. [=\left(\frac{\text{travel time}}{\text{partner}}\right)] A low value indicates a close proximity and a high value indicates a large distance.</td>
<td></td>
</tr>
<tr>
<td>Network building support</td>
<td>The variable is a dummy variable for the network building support received by the USOs. (1=received support; 0=did not receive support)</td>
<td></td>
</tr>
<tr>
<td>Linear regression</td>
<td>Mixed support</td>
<td>The variable is a rank variable for the types of support. The codification is as follows: Rank 1: Only conventional support. Rank 2: Conventional and 20% added value support or only 60% and more added value support. Rank 3: Conventional and 40% - 60% added value support. Rank 4: Conventional and 60% and more added value support.</td>
</tr>
<tr>
<td>Type of support (8 types)</td>
<td>Each variable is a dummy variable (1=received support; 0=did not receive support)</td>
<td></td>
</tr>
</tbody>
</table>
HIGH GROWTH FIRMS, PUBLIC POLICIES AND ECONOMIC GROWTH

Kashifa Suddle
EIM Business and Policy Research, P.O. Box 7001, 2701 AA Zoetermeer, The Netherlands; ksu@eim.nl

Jolanda Hessels
EIM Business and Policy Research

Erik Stam
University of Cambridge & Utrecht University

André van Stel
Erasmus University Rotterdam & EIM Business and Policy Research

Abstract
This paper investigates whether the presence of ambitious entrepreneurs is a more important determinant of national economic growth than entrepreneurial activity in general. We use data from the Global Entrepreneurship Monitor to test the extent to which high growth ambitions are reflected in GDP growth for a sample of 36 countries. The rate of ambitious entrepreneurship is defined as the percentage of adult population that is either actively involved in starting a new venture or is the owner/manager of a business that is less than 42 months old, and, in addition, expects to employ 20 employees or more within five years after the start of the firm. Our results suggest that higher levels of ambitious entrepreneurship contribute more strongly to macro-economic growth than higher levels of entrepreneurial activity in general. We find a particularly strong effect of high-expectation entrepreneurship for transition countries. The results in this paper are interpreted in light of the ongoing debate about public policies designed to stimulate high growth firms.

Keywords: entrepreneurial activity, high growth firms, growth ambitions, public policy, economic growth
1. Introduction
Entrepreneurship is considered a crucial mechanism of economic development (Schumpeter 1934; Wennikers and Thurik 1999; Baumol 2002; van Stel et al. 2005). The centrality of entrepreneurship in the current economy, or even society, is expressed as such in scientific and policy discourses as ‘the entrepreneurial economy’ (Audretsch & Thurik 2000) and ‘the entrepreneurial society’ (Ministerie van Economische Zaken 1999; Von Bargen et al. 2003). At the macro level entrepreneurship is seen as a driver of structural change and job creation. At the micro level entrepreneurship is the engine behind the formation and subsequent growth of new firms. With regard to job creation it is not new firms per se that are the key, but the relatively small number of fast-growing ‘gazelles’ that make up the lion’s share of jobs in new firms (Birch 1979; Gallagher & Miller 1991; Kirchhoff 1994; Storey 1997). In addition, these high-growth firms are characterized by rising labour productivity at the same time as they are generating jobs (Verhoeven et al. 2002; Littunen and Tohmo 2003). There has been mixed evidence on the effect of entrepreneurship in general on national economic growth (Audretsch and Fritsch, 2002; van Stel and Storey, 2004), but more consistent positive claims for high-potential start-ups (Wong et al. 2005) and fast-growing firms (Mason 1985; Kemp et al. 2000) on economic growth. High growth firms have become a central target in economic development policies. Within this group of high growth firms, high technology start-ups, also known as techno-starters, are of major importance. Nurturing high growth firms, or “gazelles”, has become a primary target and ultimate goal of entrepreneurship policy (Pages et al. 2003). As a result these high growth firms are high on the agenda of regional (Fischer & Reuber 2003), national (Smallbone et al. 2002), and supranational policy makers (European Commission 2003b). In this paper we will investigate whether the presence of ambitious entrepreneurs – regarding rapid growth – is a more important determinant of national economic growth than entrepreneurial activity in general. This relation is not straightforward as the ambitious entrepreneurs have not yet realized the rapid growth that they expect. If the ambitions would turn out to be unrealistic it could even be the case that the overoptimistic entrepreneurs actually contribute negatively to macro-economic growth.

The paper is structured as follows. We will start with a review of the literature on growth ambitions and high-growth firms. Next, we will discuss public policy aimed at high-growth firms. In the empirical part of the paper we will present the data and research method used in Section 4, while we will present our empirical analysis of the association of the presence of ambitious entrepreneurs and national economic growth in Section 5. Section 6 concludes.

2. Growth ambitions and high growth firms
Empirical research indicates that is not new firms (which are often little more than self-employed individuals) as such that are the key; but rather the relatively small number of fast-growing new firms that account for the lion’s share of net new job creation (Kirchhoff 1994; Storey 1997; Schreyer 2000; Buss 2002). These firms are successful in commercializing new ideas on a large scale. Entrepreneurial firms that are able and willing to grow may be the crucial agents of change that play a particularly important role in economic development (Audretsch 1995). Some authors have argued that entrepreneurship is not about self-employment or new firm formation per se, as most of the persons involved in this do not have an ambition to grow (Henrekson, 2005). According to Davidsson (1989) the growth of small firms is determined by the ability, need and opportunity for growth. He emphasizes that growth motivation is a necessary factor for actual firm growth. Such growth motivation is determined by the perceived ability, need and opportunity for growth. Although some objective factors directly affect actual growth, the entrepreneur’s perception of the ability,
need and opportunity for growth is major importance for explaining motivation-mediated effects on growth.

There have been several studies on the determinants of growth intentions of (nascent) entrepreneurs (Davidsson 1989; Wiklund 2001; Welter 2001). These studies found that growth intentions are positively associated with gender (male), age (young), entrepreneurial experience, experience as informal investor (Welter 2001; De Clercq et al. 2003). Perhaps more interesting for the present study are studies on the consequences of growth intentions. In general, the growth intentions of entrepreneurs are found to be positively related to actual firm growth (Bellu and Sherman 1995; Kolvereid and Bullvåg 1996; Miner et al. 1994; Mok and Van den Tillaart 1990; Wiklund and Shepherd 2003). However, this statistical relation between growth intentions and growth realizations tends to be rather weak. It is likely that the effect of growth intentions is moderated by the access to resources and the availability of opportunities. Or, to put it more strongly: in order to grow a new business, growth intentions, resources, and opportunities are necessary conditions. In practice, it remains very hard to identify high-growth firms in advance. This difficulty has led the English DTI to emphasize entrepreneurs with growth aspirations in her competitiveness policy (DTI 1998).1

Recent research found some tendencies: for example opportunity based entrepreneurship, the availability of a large information set, and a spatially broad market orientation in the start-up phase distinguishes entrepreneurs of future high growth firms from entrepreneurs of low growth firms (Vivarelli 2004; Stam and Schutjens 2005; Smallbone et al. 2002).

These insights on the role of growth ambitions of entrepreneurs have important policy implications. General measures such as tax adjustments and other regulations probably have a small effect on most self-employed, while the effect on ambitious entrepreneurs can be assumed to be quite strong. It is imperative that general measures are so designed that only those who react in the intended way are rewarded. If the self-employed with relatively low ambitions get the benefits, reactions that run counter to the intentions of the policy are not unlikely. Subsidizing entrepreneurs and new firms in general might bring about a major bias in the process of market selection. This could include substitution as well as deadweight effects (Santarelli and Vivarelli 2002; Vivarelli 2004). A deadweight effect refers to the situation in which less efficient or ambitious entrepreneurs are given subsidies, and remain in the market as long as they can use the subsidy; these entrepreneurs do not need such subsidies for improving their business. A substitution effect arises when less efficient entrepreneurs are given an artificial seedbed, while market competition would have induced them to leave the market. These effects advocate a policy oriented towards ambitious entrepreneurs. This is discussed in the next section.

3. Public policy aimed at high growth firms
Due to the important economic, social, and political roles new and small firms play in most economies, governments at all levels – federal, state/regional, and local – have designed strategies to support entrepreneurial activity. One of the most important questions regarding entrepreneurship policy is whether to stimulate new firm formation, to help existing firms survive, or to focus on (potentially) growing firms. Next, it is also important to decide on whether to aim for generic policy, or to focus on particular regions or industries. Perhaps the first question must be whether governments should be involved in supporting entrepreneurs at all. Why should governments do more than enhancing the general investment climate? Market imperfections are often used to legitimise entrepreneurship policy (Storey 2003; 2006). In the specific context of public policy aimed at (potential) high-growth firms, especially information imperfections and externalities may be important reasons for policy interventions.
With regard to information imperfections, entrepreneurs might have too negative expectations concerning the consequences of growth, and they might not realise the private benefits of obtaining expert advice from “outside” specialists. There might also be significant information imperfections at the side of financial institutions, which are unable to assess the viability and growth potential of new firms, and (on balance) overestimate the risk of lending to entrepreneurs of (potential) high growth firms.

Positive externalities may be present when social returns of certain economic activities exceed private returns. Entrepreneurs may not undertake projects which, whilst in the interest of society as a whole, yield the firm insufficient returns. The role of public policy (e.g. subsidy) is to make it privately worthwhile for the firm to undertake the project, enabling society as a whole to benefit. In the context of high growth firms, it might be that entrepreneurs do not pursue certain projects, because the risks are too high (new technology), or because they cannot fully appropriate the returns (innovation). Public policy could raise the private benefits of these projects in order to produce the social benefits, e.g. job creation and improved national productivity.

Sometimes markets are missing to a large extent, which has especially been said of certain financial markets in Europe. A lack of venture capital or opportunities for Initial Public Offerings (IPOs) at the national stock exchange, may hamper the high-growth of new firms. In the US, during the 1990s, access to finance – and in particular venture capital – played an important role in nurturing new high growth firms. In Europe, financial markets are still relatively fragmented and venture capital markets are less developed. This increases financial costs and reduces the availability of capital necessary for the growth of start-ups (European Commission 2003a).

However, one could still wonder why public policy should be aimed at high-growth firms, and not on entrepreneurship (or innovative entrepreneurship, see EIM 2002) in general. The arguments against targeting (potential) high-growth firms are (Bridge et al. 2003: 293-295):

1- Selecting potential high-growth firms is too difficult.
2- Venture capitalist are able to pick winners, with the inclusion of a considerable number of potential winners that turned out to be losers, while public policy would seek to back all the winners and avoid any losers.
3- Start-ups in general deserve policy support, due to their seedbed function, unequal access to finance and information, their employment creation (still most of the jobs in the small business sector come from non high-growth firms), their effect on regional prosperity (see also Fritsch and Mueller 2004; van Štel and Suddle, 2005).
4- What is needed is an enterprising culture, that has effect on all layers of society: new firms, small firms, large firms, public organizations.

However, there are at least as much arguments in favour of targeting (potential) high growth firms (Bridge et al. 2003: 292-293):

1- Targeting increases the **effectiveness** and **efficiency** of support measures. Focusing resources on a small group of ambitious entrepreneurs – i.e. where they are most needed and where they can produce the best results – is more effective than more generalised support. By applying support only to growth firms, the total requirements, and its cost, is reduced. This increases efficiency as a sufficient impact is made with limited resources.
2- It provides a clearer strategic focus on the needs of high growth businesses; high levels of expertise are more likely to be developed both in the public sector as well as in the related support fields (such as venture capitalists, bankers, and consultants).

3- More start-ups are not needed. In many European countries the number of start-ups has already increased enormously in the last two decades.

4- Supporting start-ups distorts the market mechanism.

In the Netherlands, public policy aimed at high-growth firms is often legitimized by an unfavorable ranking in cross-county hitlists of (potentially) fast-growing firms (Deloitte 2004; Ministerie van Economische Zaken 1999). In the yearly international Adult Population Survey of the Global Entrepreneurship Monitor (GEM) nascent entrepreneurs are being asked whether they expect to employ 20 employees or more within five years after the start of their firm. In the Netherlands the share of potential high growth new firms in 2005 is 0.26%. This is rather low in comparison with the average of the OECD-countries participating in GEM; this average is 0.61%. In European context, 0.47% expect to employ 20 or more employees within five years after the start of their firm. Countries that are very much entrepreneurial, like the US and New-Zealand, have a higher share of potential fast growers, with 1.41% respectively 1.42% (Autio, 2005). As long as The Netherlands keeps lagging behind the other benchmark countries, much more policy efforts are needed in order to improve this situation.

In order to stimulate growth ambitions in the Netherlands, the government has studied high growth firms and the specific additional bottlenecks that these firms experience in comparison with regular start-ups. According to Deloitte (2004), this group is relatively small (9%), compared with the average of the European countries (15%).

Specifically, three major bottlenecks for high growth firms occur:

1. Fast growing firms have difficulties in getting qualified employees. The employees have to function effectively in a very dynamic environment. It also takes more time and efforts to acquire and dismiss employees;

2. Fast growing firms have difficulties in getting funding or capital against reasonable conditions. Banks are distant, because they perceive a greater risk. For the target group, it is also not always clear which subsidies and regulations exist for them and can benefit them;

3. Finally, fast growing firms experience, more often than other firms, difficulties in the field of management and organisation. The division of tasks is often unclear and this makes it hard to delegate tasks.

Support for high growth firms is currently one of the three pillars of entrepreneurship policy in the Netherlands (next to start-ups and business closures/transfers; Ministerie van Economische Zaken 2004). The major aims of this high growth firms policy is more and better high growth firms, and the two indicators used for these two aims are the number of high growth firms and a reduction of the administrative burden (Ministerie van Economische Zaken 2004: 11). The policy initiatives mainly provide financial support, advice and networks to support the high growth firms.

More specific policy measures have been the Growth Plus and Fast Growth Programmes, which involved networking between, coaching of, and advice to entrepreneurs of high growth firms. These programmes originated from the European Growth Plus organization, which was founded in 1997 with the aim of promoting entrepreneurship throughout Europe by identifying top performers and role models and supporting them by sharing best practices and providing networking opportunities and political lobbying support. These top performers have annually been identified with the ranking of Europe’s 500 fastest
growing entrepreneurially led firms. Especially this networking among peers and mentoring by experienced entrepreneurs/managers has been recognized in several contexts as an effective and efficient mechanism to improve the growth of new firms (Smallbone et al. 2002; Fischer and Reuber 2003). The increased visibility of entrepreneurs of high growth firms, acting as role models, might reduce the negative expectations concerning the consequences of growth; in this respect, successful role models may have a positive effect, especially on young people early in their occupational career.3

The most recent policy actions (in 2005) have been the development of a national programme of Masterclasses for entrepreneurs of high growth firms, and the start of a Business Angel Programme that aims to connect informal investors and ambitious entrepreneurs. Port4Growth is an initiative that has been developed by the private sector, with ING, Euronext, FEM Business and Deloitte as participating organisations. Port4Growth offers a community for high growth firms and provides the infrastructure to reach other high growth firms and relevant subcontractors. Furthermore, it provides the possibility for these firms to exposure.

A mixture of technology policy and high-growth firms policy can also be observed. This is legitimised by the positive externalities involved in stimulating New Technology Based Firms (NTBFs, see e.g. Storey and Tether 1998), as these firms may be able to turn scientific knowledge into valuable products and processes (cf. Acs et al. 2005). However, this commercialisation of scientific knowledge often necessitates the development and growth of the production and marketing capabilities of these NTBFs. Two major impediments to the growth of these firms are the difficult appropriation of the value of these innovations, and the lack of management skills of the entrepreneurs involved. If these impediments are not taken away, valuable innovations may never be introduced into society. In the Netherlands this mix of technology policy and high-growth firms policy has been central in the policy initiatives to stimulate the growth of new firms in biotech (Biopartner Programme: www.biopartner.nl) and ICT (Twinning Programme). These initiatives have recently been integrated in the TechnoPartner Programme (www.technopartner.nl). The TechnoPartner Programme has become operational in mid-2004 and aims for more effective spin-offs from research institutes. Besides the encouragement of the exploitation of knowledge by research institutes, this programme aims to improve the capital market for techno-starters. Furthermore, techno-starters will get more personalised and effective information and advice. Third, the government is investigating whether the American SBIR scheme (Small Business Innovation and Research scheme) can be applied in the Netherlands. The SBIR scheme aims to stimulate research and development by innovative SMEs. In order to do so, the scheme subsidises the development of innovative ideas, the development of the prototype and provides an official quality endorsement at the moment of the commercialisation of the product. Another recent initiative is the attempt by the Dutch Ministry of Economic Affairs to replicate the successful Small Business Innovation Research (SBIR) Programme of the US (see e.g. Lerner 2003). This programme stimulates innovative research in SMEs, and is likely to stimulate the growth of new and small technology based firms.

Unfortunately, there are hardly any evaluations of policy interventions to stimulate high-growth firms. This makes it hard to derive normative implications from this overview of public policy aimed at high growth firms. The least we can do is investigating whether the prevalence of ambitious entrepreneurs has an effect on national economic growth at all. In the next sections we will present empirical evidence on this issue.

4. Data and research method
In the current study we investigate whether the presence of ambitious entrepreneurs is a more important determinant of national economic growth than entrepreneurial activity in general.
Our empirical analysis builds on van Stel et al. (2005). They investigate whether Total Entrepreneurial Activity (TEA) - defined as the percentage of adult population that is either actively involved in starting a new venture or is the owner/manager of a business that is less than 42 months old - influences GDP growth for a sample of 36 countries. The authors find that the TEA index indeed affects economic growth but that the influence depends on the level of economic development. In particular the contribution to economic growth is found to be stronger for more highly developed countries (as compared to developing countries).

In this paper we will perform a similar regression analysis but next to the general TEA index, we will also use the TEA high growth rate and the TEA medium growth rate as independent variables and compare their impact on economic growth with the impact of the general TEA index. The TEA high (medium) growth rate is defined as the percentage of adult population that is either actively involved in starting a new venture or is the owner/manager of a business that is less than 42 months old, and expects to employ 20 (6) employees or more within five years after the start of the firm. TEA rates are taken from the Global Entrepreneurship Monitor, Adult Population Survey 2002.

Our dependent variable is the average annual growth of GDP during the period 2002-2005. The growth rates are taken from the IMF World Economic Outlook database. As control variables we use the log of gross national income per capita 2001 (GNIC; source World Bank, WDI database), to correct for possible catch-up effects of poorer countries. We also use data on competitiveness, capturing important factors that determine the capacity of national economies to grow (next to entrepreneurship). More specifically we use the Growth Competitiveness Index (GCI) 2001 from The Global Competitiveness Report. As a final control, we include lagged GDP growth to correct for possible reversed causality effects.

We use a sample of 36 countries participating in the Global Entrepreneurship Monitor (GEM) in 2002. Following van Stel et al. (2005) we allow for the possibility of different effects of highly developed and developing countries. In addition we also test whether the effect of TEA is different for transition countries. For a more elaborate discussion of the model we refer to van Stel et al. (2005).

5. Entrepreneurial growth ambitions and national economic growth

The results of our empirical exercises are in Tables 1-3. In Table 1 the regression results of the impact of the general TEA index are presented, while Tables 2 and 3 show the results using the TEA medium growth and TEA high growth rates as main independent variables. The possibly different impacts of rich versus poor (Model 2) or highly developed vs transition vs. developing countries (Model 3) is allowed for by defining separate entrepreneurial activity variables for each group of countries.
Table 1: Explain economic growth from TEA rate

<table>
<thead>
<tr>
<th>TEA</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>19.6 **</td>
<td>26.1 **</td>
<td>22.2 **</td>
</tr>
<tr>
<td></td>
<td>(4.2)</td>
<td>(3.0)</td>
<td>(2.5)</td>
</tr>
<tr>
<td>TEA</td>
<td>0.047</td>
<td>0.087 *</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.8)</td>
<td>(1.8)</td>
<td></td>
</tr>
<tr>
<td>TEA rich</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEA poor</td>
<td>-0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEA highly developed</td>
<td></td>
<td>.11 **</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.2)</td>
<td></td>
</tr>
<tr>
<td>TEA transition</td>
<td></td>
<td>.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.4)</td>
<td></td>
</tr>
<tr>
<td>TEA developing</td>
<td></td>
<td>.023</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.2)</td>
<td></td>
</tr>
<tr>
<td>log (GNIC)</td>
<td>-2.2 **</td>
<td>-2.8 **</td>
<td>-2.4 **</td>
</tr>
<tr>
<td></td>
<td>(2.8)</td>
<td>(2.7)</td>
<td>(2.6)</td>
</tr>
<tr>
<td>GCI</td>
<td>.62</td>
<td>.64</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>(0.7)</td>
<td>(0.8)</td>
<td>(0.7)</td>
</tr>
<tr>
<td>Lagged gdp growth</td>
<td>.37 **</td>
<td>.30 **</td>
<td>.22</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td>(2.1)</td>
<td>(1.2)</td>
</tr>
<tr>
<td>R²</td>
<td>0.626</td>
<td>0.636</td>
<td>0.662</td>
</tr>
<tr>
<td>adjusted R²</td>
<td>0.577</td>
<td>0.576</td>
<td>0.592</td>
</tr>
</tbody>
</table>

Absolute heteroskedasticity-consistent t-values are between brackets. Dependent variable is average annual growth of GDP over the period 2002-2005. TEA is Total Entrepreneurial Activity rate (Global Entrepreneurship Monitor); GCI is growth competitiveness index 2001 (Growth Competitiveness Report); GNIC is per capita income of 2001; Lagged GDP growth is average annual growth of GDP over the period 1998-2001.

* Significant at a 0.10 level.

** Significant at a 0.05 level.
### Table 2: Explain economic growth from TEA medium growth rate (growth ambition > 6 employees within 5 years)

<table>
<thead>
<tr>
<th>TEA medium growth (6+)</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>19.8 ** (4.6)</td>
<td>22.0 ** (3.5)</td>
<td>21.5 ** (4.5)</td>
</tr>
<tr>
<td>TEA_hg6</td>
<td>.17 (1.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEA_hg6 rich</td>
<td></td>
<td>.22 * (1.8)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg6 poor</td>
<td></td>
<td>.12 (0.9)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg6 highly developed</td>
<td></td>
<td>.26 ** (2.2)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg6 transition</td>
<td></td>
<td>.50 ** (3.1)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg6 developing</td>
<td></td>
<td>.090 (1.0)</td>
<td></td>
</tr>
<tr>
<td>log (GNIC)</td>
<td>-2.2 ** (2.9)</td>
<td>-2.4 ** (2.7)</td>
<td>-2.4 ** (3.3)</td>
</tr>
<tr>
<td>GCI</td>
<td>.58 (0.7)</td>
<td>.58 (0.7)</td>
<td>.74 (0.9)</td>
</tr>
<tr>
<td>Lagged gdp growth</td>
<td>.35 ** (2.6)</td>
<td>.33 ** (2.3)</td>
<td>.20 (0.9)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.638</td>
<td>.641</td>
<td>.679</td>
</tr>
<tr>
<td>adjusted $R^2$</td>
<td>.592</td>
<td>.582</td>
<td>.612</td>
</tr>
</tbody>
</table>

Notes are as in Table 1.

### Table 3: Explain economic growth from TEA high growth rate (growth ambition > 20 employees within 5 years)

<table>
<thead>
<tr>
<th>TEA high growth (20+)</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>19.8 ** (4.3)</td>
<td>19.5 ** (2.9)</td>
<td>20.0 ** (3.5)</td>
</tr>
<tr>
<td>TEA_hg20</td>
<td>.27 (1.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEA_hg20 rich</td>
<td></td>
<td>.25 (1.1)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg20 poor</td>
<td></td>
<td>.28 (1.0)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg20 highly developed</td>
<td></td>
<td>.29 (1.3)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg20 transition</td>
<td></td>
<td>.70 ** (2.7)</td>
<td></td>
</tr>
<tr>
<td>TEA_hg20 developing</td>
<td></td>
<td>.17 (0.8)</td>
<td></td>
</tr>
<tr>
<td>log (GNIC)</td>
<td>-2.2 ** (2.9)</td>
<td>-2.2 ** (2.3)</td>
<td>-2.3 ** (2.9)</td>
</tr>
<tr>
<td>GCI</td>
<td>.68 (0.8)</td>
<td>.68 (0.8)</td>
<td>.90 (1.1)</td>
</tr>
<tr>
<td>lagged gdp growth</td>
<td>.34 ** (2.4)</td>
<td>.34 ** (2.3)</td>
<td>.22 (1.0)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.637</td>
<td>.637</td>
<td>.667</td>
</tr>
<tr>
<td>adjusted $R^2$</td>
<td>.590</td>
<td>.576</td>
<td>.598</td>
</tr>
</tbody>
</table>

Notes are as in Table 1.
Table 1 confirms earlier findings of van Stel et al. (2005) that it is important to distinguish between different groups of countries. While for rich countries the impact of entrepreneurial activity is significantly positive, the impact for poor countries is effectively zero. Furthermore the three tables reveal three important results. First, as hypothesized, the presence of ambitious entrepreneurs indeed seems to be more important for achieving GDP growth than entrepreneurship in general. Comparing the coefficients of the various TEA rates across the tables, we see that in each of the three model variants the impact of TEA medium growth (growth ambition of 6 employees) is higher compared to the impact of TEA in general, while, in turn, the impact of TEA high growth (growth ambition of 20 employees) is still higher. For instance, for the group of highly developed countries in Model 3, the TEA rate has a coefficient of 0.11 (Table 1), while the coefficients of the TEA medium and high growth are 0.26 and 0.29, respectively.

Second, having more entrepreneurs with high growth ambitions seems to be particularly important in transition countries. Both the magnitude and the statistical significance of the estimated coefficient point at a stronger impact compared to highly developed or developing countries (see Tables 2 and 3). It may be argued that in transition economies opportunities are more widely available and hence, a higher number of ambitious entrepreneurs willing to act on these opportunities may be particularly fruitful for achieving growth in these countries.

Third, comparing the coefficients of the various TEA metrics over the three tables, it may be argued that it is important to have a substantial number of entrepreneurs with growth ambitions per se but that it is not so important whether these entrepreneurs expect to employ at least 6 employees or at least 20 employees. The differences between coefficients in Tables 2 and 3 are not that large. Also note that the model fit in Table 2 (TEA medium growth) is higher than that in Table 3 (TEA high growth).

Our regression results should be interpreted with some care as the analysis is based on a limited number of observations.

6. Conclusion
It would be naïve to recommend to focus policy completely on ambitious entrepreneurs and their (potentially) fast-growing firms. Economic growth is most likely achieved with a mix of small but high-growth firms and large, mature firms (Baumol 2002; Nooteboom 1994). However, the Netherlands, just like most European countries, has sufficient large firms, but seems to be lacking a sufficient number of these high-growth new firms (see Bartelsman et al. 2005).

In this paper we assumed that the presence of ambitious entrepreneurs leads to economic growth via the successful development of their firms. Indeed, our empirical analysis does suggest that high-expectation entrepreneurs contribute more strongly to economic growth at the macro-level than entrepreneurs in general. This effect seems to be particularly strong in transition countries. However, we could not directly trace the assumed success at the micro-level of analysis. It would be worthwhile to follow the high potential startups to establish whether such firms fulfill their promised potential and what factors influence their subsequent success or failure. Such research would cast light on the nature of the phenomenon, including the characteristics of individuals, the effect of environmental factors and the mechanism of the development path of high potential startups. We should also be careful not to regard high ambitions as valuable in itself, as entrepreneurs may also be too ambitious in comparison with the financial resources that they have access to, which leads to a premature death of the new firm (Littunen, 2000).

Understanding the transition from growth ambitions into growth realizations allows more effective policies to be drawn to encourage and stimulate entrepreneurial activities with
growth potential. To this end more longitudinal research at the micro-level of analysis will be required.

Notes

1 The main rationale for this programme is the potential welfare gains to the economy which will result from enabling more new businesses with growth potential to achieve significant growth (DTI 1999). There is an implicit assumption of market failure in the sense of the support needs of high-growth start-ups not being adequately met by the private sector. The programme is also legitimated by its additionality to the existing start-up support. High growth potential of start-ups is defined as an aspiration of £1 million sales per annum. It is estimated that only about 1% of new business start-ups in the United Kingdom each year achieve annual sales of this amount. Achieving £150 000 sales within twelve months is provided as a stepping stone goal toward this threshold.

2 According to Davidsson (1991, p.424) persuasive attempts to stimulate growth motivation are likely to be most effective if directed at younger firms and younger owner-managers. Younger firms have a stronger objective need for expansion, and their values, attitudes, and ‘company cultures’ are less likely to be firmly held. Younger individuals are also likely to be more sensitive to growth objectives than older entrepreneurs that have since long defined and lived up to a role as the manager of a stable firm.

3 The 36 countries in our sample are: Argentina\textsuperscript{D}, Australia, Belgium, Brazil\textsuperscript{D}, Canada, Chile\textsuperscript{D}, China\textsuperscript{T}, Taiwan, Denmark, Finland, France, Germany, Hong Kong, Hungary\textsuperscript{T}, Iceland, India\textsuperscript{D}, Ireland, Israel, Italy, Japan, Korea, Mexico\textsuperscript{D}, Netherlands, New Zealand, Norway, Poland\textsuperscript{T}, Russia\textsuperscript{T}, Singapore, Slovenia\textsuperscript{T}, South Africa\textsuperscript{D}, Spain, Sweden, Switzerland, Thailand\textsuperscript{D}, United Kingdom and United States. Mark \textsuperscript{D} indicates developing country while mark \textsuperscript{T} indicates a transition country. In the categorisation rich versus poor, eleven of the twelve countries marked as \textsuperscript{D} or \textsuperscript{T} are classified as (relatively) poor, the exception being Slovenia.

4 Van Stel et al. (2005) refer to a possible lack of larger companies in these poorer countries as a possible explanation for the zero effect of entrepreneurial activity.

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DO BIRDS OF A FEATHER FLOCK TOGETHER?
THE FINANCING OF UK SOFTWARE AND BIOTECHNOLOGY FIRMS AT
THE EARLIER STAGES OF BUSINESS DEVELOPMENT

By

Dr Farid Ullah* and Professor Peter Taylor

The University of Glamorgan
Department of Enterprise and Economic Development
Business School
Treforest, Pontypridd,
CF37 IDL
Wales
United Kingdom
E-mail: fullah@glam.ac.uk
Tel: 01443 483 370
Fax: 01443 483 650

* Corresponding author
Do birds of a feather flock together?
The financing of UK software and biotechnology firms at the earlier stages of business development

Abstract
This paper explores the funding issues at the early stages of development of small biotechnology and software firms in the UK. The paper reviews theory and evidence on firms in these two sectors and presents empirical evidence for the UK derived from an extensive on-line questionnaire survey. The sample consists of 41 small biotechnology firms and 42 software firms representing a sub-sample of a larger sample of 133 high technology small firms (HTSFs) or technology-based small firms (TBSFs). As a sub-group of Small and Medium-sized Enterprises (SMEs), HTSFs face a number of obstacles to their business development. Finance is believed to be one of the main problems particularly at the early stages of their development. HTSFs encounter financing problems mainly because of their embryonic nature, young age, lack of collateral, lack of business skills, lack of market presence, high technical area and other factors.

The main findings from this study suggest that entrepreneurs in the biotechnology sector reported higher academic qualifications than the other group. The founders of software firms are younger than the biotechnology firms. Firms in both groups have grown in terms of full-time employees. In terms of funding problems, software firms report more funding problems than the biotechnology firms. Software firms are fastest growing firms and goes through the early stages of development quickly than the biotechnology group. With regards to the sources of funding the evidence shows that biotechnology small firms mainly use venture capital finance whilst the main source of funding for the software firms is personal savings and bank finance. However, biotechnology small firms report difficulties in securing equity finance. Software firms seem to be constraining their growth by the demand side financial constraints.

The two groups of HTSFs in this study suggest that high technology small firms may have particular needs for finance and that these may change as they develop through early stages of business development. The paper present evidence on these issues and suggest differences in the experience of biotechnology and software firms in terms of financing.

Keywords: SMEs, HTSFs/TBSFs, biotechnology small firms, computer software small firms, research and development, entrepreneurship, innovation and venture capital.
1. Introduction

The attitudes towards small firms and their role in economic development were very different some forty years ago. Then, it was believed that large firms are more important and more capable of competing in the world markets and therefore, mergers and acquisitions were supported. However, since the 1970s, the attitudes started changing as massive changes were also occurring on the global level (such as the oil price shocks). On a more national level in the UK, there were massive unemployment as a result of major decline in the textile industry and other industrial sectors. This was mainly due to the other emerging economies on the world economic map such as China and other Asian economies competing with the UK products in international markets. The UK large industries were unable to compete due to the relative expensiveness of their products and services. However, in this turbulent time, a creative destruction was also taking place. In order to survive and adjust to new economic challenges, there was a need for small businesses everywhere.

Parallel to this general economic restructuring, there were also particular changes occurring in the way the academic institutions were working. Previously, academic institutions were heavily state sponsored and academics were seen as people away from the real business world. Their main role was teaching and research. However, this was also undergoing major changes. Public financial support to academic institutions was heavily cut and the emphasis on generating own income was rising. Academic research must have to be transformed into economic value. This lead to the increasing involvement of academic institutions with industry. In this context in the UK in particular and elsewhere generally, there was a trend to establish property based initiatives such as science parks and incubators. The main aim was to support small firms established as a result of the academic research in universities and other higher education institutions. Briefly, a new economic structure was beginning to emerge and gaining strength with the passage of time.

In this new economic framework, small firms in general and high-technology small firms in particular are increasingly seen as the source of new ideas, innovation, job creation, regional, national and international economic development. Technology-based small firms are seen by many as a US phenomenon but nowadays almost every advanced economy and increasingly the developing countries are obsessed with the establishment of TBSFs and perceive them as a key to economic development.

In this context, the role of TBSFs as engines of economic growth is well recognised and has attracted much public and private attention not only in the UK but internationally as well and there is a growing academic and policy-related literature on the subject. It is believed that the invention and innovation provided by TBSFs, particularly in sectors such as computer software and hardware, biotechnology, pharmaceuticals, life sciences, communications and other aspects of high-technology is vital for economic growth and development. The extraordinary success and performance of Silicon Valley and Route 128 technology-based start-up businesses in the US is seen by many as the sine-qua-non of future economic and business development (Berger and Udell, 1998).

TBSFs go through certain stages of development in their life cycle as depicted in Kazanjian (1988), Clark and Guy (1998), Oakey (2003) and Ndonzuau, Pirnay and Surlemont (2002). Depending on the nature of the technology and potential markets for TBSFs, finance could be a serious problem at early stages of business development. It is argued that due to their special characteristics, TBSFs may find particular environment such as science parks and incubators as ideal places for their growth and early stages of development. This paper focuses on the financial needs and experiences of 42 computer...
software firms and 41 biotechnology firms at the early stages of their business development. This paper is attempting to increase our understanding of the differences between software and biotechnology small firms in the UK. We believe that this increased insight will have important policy implications and a guide for financiers. The rest of the paper follows this structure: Section 2 discusses the main literature on the financial issues of TBSFs. Section 3 discuss the methodology and methodological issues. Section 4 provides the empirical evidence gathered on the financing issues of the sampled firms. Section 5 concludes the paper and identifies the future research in this area.

2. Literature review

There is a huge literature available on small firms and particularly on the financing issues of small firms. We can categorise this vast literature into three main categories: firstly there are public reports and enquiries conducted on behalf of the UK government; secondly theoretical models and explanation of the funding gap and thirdly there are empirical studies which mainly confirms the theoretical models. There are many other studies investigating different aspects of the HTSFs business development but to provide a comprehensive overview of all HTSFs literature is beyond the scope of this paper. Therefore, we limit ourselves to the main literature on HTSFs funding issues.

The UK government has always taken an active interest in the finance problems of small firms. The history of public investigation into the funding gap goes back to the times of great depression. Bolton (1971) and Wilson (1979) presented their reports on finance for small firms. The Bolton Committee (1971) reported that there was no institutional deficiency in the financial markets for small firms in the UK and the Wilson Committee (1979) did not find any evidence that suggested a general shortage of finance for small firms in the UK. However, the main focus of these public enquiries was on the SME sector rather than focusing in detail on the particular sub-groups (such as TBSFs) of the SME population. The first public report that addressed the problems of the TBSF sector was that of the Advisory Council on Science and Technology (ACOST) in 1990. This report focused on TBSFs finance and the financial constraints that these firms encounter at critical stages of development. The report concluded that due to the higher risks associated with TBSFs and the difficulties in assessing their technology and high innovative nature, institutional investors (particularly banks) were hesitant to provide financial assistance.

In response to an increasing concern over the finance issues of TBSFs the Bank of England has reported regularly on this subject. Its first report on the financing of technology-based small firms was published in 1996 and this report suggested that TBSFs may face financial constraints at start-up and early stages of development and that these constraints might be due to market imperfections. The report argued that finance providers find it hard to assess the viability of TBSFs business ideas due to their scientific basis or high-technology nature of their products and as a result remain cautious. Quite recently, the Bank of England (2001) report found that finance constraints at early stages of development were a particular problem for those TBSFs which were at distance from technology clusters. The House of Lords Select Committee (1997) and the Confederation of British Industry (CBI) report on Tech-Stars (CBI, 1997) also reflected these views and suggested that since at start-up TBSFs do not generally have viable products, it is extremely difficult to assess the size of potential markets and it is difficult to evaluate the technological risks. This increases the risk for financiers to invest in such products. The Select Committee suggested that TBSFs should be encouraged to use incubators and science-parks to improve mutual understanding and help overcome the associated risk and information asymmetries.
Similarly, the Williams (1998) report suggests that equity finance is more appropriate than debt assuming that TBSFs have no earnings at the early stages, hence difficult to repay loans whilst Modigliani and Miller (1958) suggest that once a project shows some earnings, debt could be retired and replaced with an equity issue at much better prices or through retained earnings. This justifies the important role of the venture capital industry in the UK and in the absence of such a role and a focus on the Management buy-in (MBI) and Management buy-out (MBO) is a cause for concern. Williams report also compare venture capital investments in TBSFs early stages in the UK with the US and show that according to the 1997 statistics, US venture capital industry invested £5800 million while the corresponding figure for UK is only £349 million. Murray and Lott (1995) find that US VCFs invest three times more than their UK counterparts in young new technology-based firms after taking away the MBI and MBO investments. In US, VCFs tend to invest more in the early stages of TBSFs whilst in the UK VCFs has a tendency towards MBO/MBI and other later stages. Moreover, Wright and Robbie (1998) suggest that there are marked differences between the informal investors of UK and other countries such as US and Sweden.

Oakey (2003) notes that the TBSFs funding problem is deep rooted due to free market policies in the 1970s and 1980s. He suggests an integrative support by the public and private sectors for TBSFs finance. He argues that due to short-termism and associated risks, there exist a temporal-gap and a risk-gap for TBSFs. Oakey’s hypothesised temporal-gap suggests that the available public support diminishes at a point when TBSFs product is not yet ready for the market and that there is a five-year funding gap in the development of a product. The risk-gap notions suggest that as many as 50% TBSFs are clearly unfundable, 30% are probably unfundable, 10% in the critical area of being probably fundable and as little as 10% receiving funding. Accepting this analysis means that even if the probably fundable all receive funding, only 20% of the TBSFs population are funded. Westhead and Storey (1997) suggest that most technologically sophisticated firms report that their growth has been impeded by a continual financial constraint.

One of the reasons most cited in the literature on why TBSFs have financing problems is information opacity. Leland and Pyle (1977), Sahlman (1990), Myers and Majluf (1984) suggest that financial markets are informationally opaque and that borrowers know more about the potentials and nature of their businesses than do lenders. Similarly Admati and Pfleiderer (1994), Aghion and Bolton (1992), Amit Glosten and Muller (1990), Bergemann and Hedge (1998), Cable and Shane (1997), Chan Seigel and Thakor (1990), Demsetz (1969), Dewatripont and Tirole (1994), Fama and Jensen (1983) and Jensen and Meckling (1976) all address the agency problems where an entrepreneur and financier interact with conflicting interests.

Empirical studies such as Berger and Udell (1998), Trester (1998), Wright and Robbie (1996), Wright and Robbie (1998), Himmelberg and Petersen (1994), Jordan, Lowe and Taylor (1998) and Leland and Pyle (1977) suggest that ‘information asymmetry’ is the most important characteristic of small business finance which is most acute in the case of TBSFs.

Dewatripont and Tirole (1994) suggest that the involvement of external financiers reduces the riskiness of the new ventures and resolves the problems of moral hazard and adverse selection. On the other hand Jordan, Lowe and Taylor (1998) and Himmelberg and Petersen (1994) suggest that small firms are riskier both for debt and equity investors and the founders’ concern about loss of control determine the capital structure.

Dixon (1991), Muzyka, Birley and Leleux (1996), suggests that venture capitalists is looking for an experienced management team while investing in a firm. Projects
without a good management team and reasonable idea but with good financials appear to be meaningless. MacMillan, Siegel and Narasimha (1985) also find that the most frequently used criterion is the quality of the entrepreneur.

Differentiating the supply-side financial constraints from the demand-side financial constraints, Cressy and Olofsson (1997) suggests that a supply-side financial constraint means a capital market imperfection that leads to a socially incorrect supply of funds to projects (e.g. different funds as in the case of rationing) or the incorrect interest rate charged on funds. On the other hand, the demand-side financial constraint is a capital market imperfection in which performance of a firm is adversely affected by a factor internal to the firm. For example if a firm’s owner wants to grow the firm, but the only way to grow is to relinquish equity and he/she do not want to do so. In such a situation they suggest the demand for funds is demand constrained.

Finally, Moore and Garnsey (1993) explore the effects of the SMART (Small firms Merit Award for Research and Technology) scheme. They conclude that the successful operation of SMART scheme justifies the government intervention since information asymmetries are reduced with the support of SMART. This appears to create added value to firms as non-winners under the SMART scheme are expected to face further financial problems during the life cycle of innovation. Similarly, Lerner (1999) examines the impact of the Small Business Innovation Research (SBIR) programme in the US and argues that SBIR winners grew significantly faster than non-winners and were more likely to attract venture finance.

This brief literature review suggests that the main arguments for HTSFs financial problems are believed to be information opacity (which leads to moral hazard and adverse selection problems), the unwillingness to give up equity in return for finance, high technicality of the business product/service, inexperience of the founding team, lack of tangible assets etc. This paper explores these funding issues for the UK software and biotechnology firms and is attempting to provide further understanding of these issues and guide policy and practice in tackling the finance problems of HTSFs.

3. Methodology, methodological issues and data collection

This paper discusses the most crucial problem of finance for UK TBSFs in the computer software and biotechnology sectors. The empirical evidence reported here was originally collected for a comparative study of on-park and off-park firms to explore the funding problems of TBSFs at their early stages of development and the contribution of location in overcoming the finance problems. Using electronic survey questionnaire between 20th November 2002 and mid March 2003, we received 133 (22.45%) usable responses which were recorded in SPSS for analyses. The current sub-sample consists of 41 biotechnology and 42 software small firms which represents 62.41% of our total 133 responses.

The sample selection process involved obtaining lists of TBSFs from the United Kingdom Science Parks Association (UKSPA), the United Kingdom Business Incubation (UKBI) websites. The off-park firms were selected from the FAME data source (accessed through the Liverpool University library catalogue) and technology cluster websites. We encountered some problems in the data collection process. In most cases the contact details (e-mails and telephone numbers) of individual firms obtained from the UKSPA/UKBI websites were wrong and e-mails were bouncing. We tried our best to overcome this problem and increase our responses but at the end after at least three reminders and careful planning we managed only 133 usable responses.

Using internet as a data collection tool is quite new. It has both its merits and demerits. Among the advantages we can say that it is fast, almost free (if you have
internet connection), trendy, bulk free, easy follow up, technologically relevant to TBSFs and easily manageable. Postal and telephone surveys on the other hand can be very expensive, time consuming, bulky and old-fashioned. On the other hand demerits of electronic surveys include the blocking of e-mails by Internet Service Providers (ISPs), respondents may not open e-mails from unknown or un-trusted sources due to the fear of viruses, there are privacy issues as many respondents believe that transmitting valuable and confidential information may be viewed by others and there are methodological problems such as sampling bias.

Whatever the strengths and weaknesses of a chosen methodology for data collection, it is true that no research design will be perfect since all involve compromises. For instance, all researchers, particularly individuals working alone (such as PhD students) have to accept that their resources are finite. Often researchers admit, ex post facto, that if they were starting again, they would amend or even choose a different research design to the one they actually used (Curran and Blackburn 2001, p. 87).

However, in spite of a very small sample we believe that this paper will contribute to the existing knowledge and increase our understanding about the financing of UK TBSFs in software and biotechnology sectors.

4. Empirical evidence:

4.1 Demography and taxonomy of sample firms

Figure 1 shows that the highest level of qualifications among biotechnology firms is doctorate (22% compared to 10% software firms). However in terms of undergraduate, graduate and postgraduate education, software firms shows higher qualifications than biotechnology firms. The highest doctorate qualifications may indicate that biotechnology entrepreneurs are scientists and their products/services may encounter different impediments (particularly accessing external funds) than software firms at the early stages of business development.

![Figure 1: Level of qualifications between software and biotechnology small firms](image1)

Figure 2 provide information on the age distribution of respondents. It is clear that for computer software firms most of the respondents are in the three age band 26-30, 31-35 and 36-40. Software entrepreneurs are also higher in the age band 20-25 compared to
biotechnology firms. Biotechnology entrepreneurs are mostly in the age band 31-35, 36-40 and 41-45. Majority of software entrepreneurs are in the age band 36-40 and for biotechnology they are in the age band 41-45. Biotechnology entrepreneurs are also more in numbers at the age band 46-50 compared to software entrepreneurs. The figure indicates that software entrepreneurs are comparatively younger than the biotechnology entrepreneurs and this may have important implications for finance. Financiers may perceive that being young would mean less experience, less competence, and lower business and management skills whilst biotechnology entrepreneurs who are older may mean more experience, having business and management skills, which many finance providers expect from entrepreneurs. However, being young also mean more energetic, sharp and committed which are good attributes for business success. This may have important implications for both policy makers and finance providers.

Figure 2: Age distribution of respondents between the two groups

Figure 3 provides information on the founder co-founder of the two groups in this study. It is clear that among software firms higher numbers of founders and co-founders are still present compared to biotechnology firms. Interestingly significant numbers of biotechnology entrepreneurs (38%) compared to software entrepreneurs (5%) reports that they were not involved as founders in establishing the business.
This structure of sample businesses may have important implications for finance as founders have strong views about their businesses than non-founders. Keeping control of the business may be more important for founders than non-founders which may consequently impact the attainment of equity finance as equity providers may be demanding higher stakes in the business.

Figure 4 shows the business origins of the sample firms. The figure indicates that majority of software businesses (67%) are established as new ideas of individuals or group of individuals compared to 46% for biotechnology firms. Another important feature of biotechnology firms in this study is that higher percentages of these firms are spin-offs from universities (27% biotechnology compared to 12% software), non-university research organisation (12% biotechnology compared to 7% software) and corporate spin-offs (12% biotechnology compared to 10% software). It is important to note that spin-offs may have an advantage of getting funds from public sources as research work undertaken in academic or other institutions may be supported from public funds. Even in the case of corporate spin-offs, parent companies may provide financial assistance to newly established firms. In such a situation the computer software firms are relatively at a disadvantage to access funds for early stage development as they are established as a result of individual or group of individuals own ideas.
High technology firms are also high growth firms. Figure 5a and 5b tells us about the employee growth in the two groups. The full-time employee growth in figure 5a indicates that among software firms there is a significant growth of employees (both mean and median) since start-up. However, these firms are still very small (micro firms having less than 10 employees) and managed by the original founder co-founder as explored earlier.

For biotechnology firms in this study, figure 5b shows that the growth (mean and median) in full-time employees has gone up considerably. These firms seem to have
grown considerably more compared to software firms as they have crossed the limit for micro firms.

![Figure 5b: Number of full-time employees at start and now for biotechnology firms](image)

It seems that they are now small firms having more than 10 but less than 50 employees. This also confirm the findings in the previous figures which showed that these firms are established as a result of research in universities and other organisations and may be currently managed by majority shareholders and not original founders. This has important implications for the capital structure of the firms as shareholders may be more willing to seek external finance than the founders who ‘would wish to keep control of the business’ at the expense of growth.

### 4.2 Funding environment of the software and biotechnology firms

Figure 6 explores the issue of funding for the two groups in this study. It is clear that computer software firms report higher refusal rates than biotechnology firms.
This may be due to various reasons. For instance due to the burst of the software bubble in 2000, financiers are more risk averse than before and see these firms as more risky. Another reason may be that software products/services are highly risky and go out of date quickly and therefore financiers may think that before they reap the benefits of their investment the technology they are investing in might be too old. However, this may also be reflecting the findings in the previous sections where we found that software firms are different in many respects than the biotechnology firms which may be negatively influencing its financial problems.

A common feature of technology-based firms is that they follow a certain path commonly known as life-cycle. This life cycle of TBSFs is analogous to the conception and development of a human baby. These firms usually originate from cutting edge research carried out in universities, higher education institutions and large companies. Prior to their full visibility in the market, they go through different phases of transformation and incubation. Figure 7 indicates these stages of development among the two groups in this study.

![Figure 7: Stages of development between software and biotechnology firms](image)

It appears that 76% computer software firms are at the expansion stage of development compared to 50% of biotechnology firms. The figure also reflects the transitory nature of software firms and the gradual development of biotechnology firms. Understanding these developmental stages of sample firms is helpful in knowing at what stage of development TBSFs are most financially constrained. In order to avoid confusion, we report the degree of financial difficulties in two separate figures for the two groups. Figure 8a shows the degree of financial difficulties for software firms. It is clear that software firms are experiencing highest financial difficulties at the concept development (88%) and product development (73%) and moderate financial difficulties at the initial marketing stages. At expansion stage firms become more credible, gains experience and get a foothold in the market. This increased visibility may positively influence the potential investors.
Similarly figure 8b for biotechnology firms shows a mixed picture of financial difficulties at various stages of development. However, firms still report (in descending order of strength) that financial difficulties are serious at concept development, product development, initial marketing and expansion stage which is a similar pattern to software firms but may be different in severity. This means that both groups have financial difficulties at earlier stages but with different strength greater for software than biotechnology firms).

Having established the fact that both groups of firms in this study reports funding difficulties at various early stages of development, the next issue is to explore what main sources of external finance have these firms attempted. Literature suggests that equity finance is more appropriate for TBSFs than debt. Some studies suggest that small firms follow a pecking order whilst financing their activities. Figure 9 shows the level of external finance (equity finance) for the two sample groups.
This figure shows that the main sources of external finance such as VCs, business angels, banks and public sources are investing comparatively more in biotechnology firms than computer software firms. Software firms seem at a disadvantage than biotechnology firms. This is very crucial finding for UK policy makers as the aim is to increase the mass of TBSFs in all high-tech sectors not just biotechnology. This is also important for financiers as other countries such as US and Ireland have benefited enormously from investing in computer software firms.

Figure 10 informs us about the extent of difficulty encountered by the two groups in securing external finance. It is indicated that computer software firms reports the highest difficulties in securing outside equity compared to biotechnology firms. This may lead us to believe that in the UK, computer hardware/software firms are finding it harder to secure funds for early stage business development than biotechnology firms. This also reflects and confirms the pattern found in the preceding figures in this study.

Figure 11a reveals the sources of finance used by the software firms. Personal savings is the main source of finance. The second most important source of finance is the VC finance and thirdly the house mortgage/re-mortgage. Previous studies also finds that personal savings of entrepreneurs is the most important source of finance at the start of the business. It is interesting that software firms are getting financial support only from small firms loan guarantee scheme (SFLGS) and not any from SMART (Small Firms Merit Award for Research and Technology) and SPUR (Small Products Under Research).
This is extraordinary as these schemes are aimed at providing financial support to young high technology firms at earlier stages. However, due to the smallness of our data it is difficult to draw general conclusions from these findings.

Figure 11a: Sources of finance used by the software firms

Figure 11b shows the sources of funding for biotechnology firms in this study. Both statistical measures show that VC finance is the most important source of finance for biotechnology firms. The second important source is the business angels. Personal funds and funds from family are important sources of early stage funding but not as highly important as it is for software firms. Other interesting finding is that in addition to SFLGS, SMART and SPUR schemes are also investing in biotechnology firms in this study. However, house mortgage/re-mortgage is totally non-existent as a source of funding for biotechnology firms. Once again to draw definitive conclusions from this small sample data is difficult.
5. Conclusions and discussions:

This paper has explored the important issue of funding for UK software and biotechnology small firms. Although the sample size is very small but is quite acceptable for qualitative survey studies. Software and biotechnology sectors are the two main groups of high technology population in the UK. This enables us to draw some broad conclusions.

With regards to the entrepreneurs’ demography and their ventures characteristics we found that majority of biotechnology entrepreneurs’ holds doctorate level qualifications which may be reflecting the scientific base of their businesses. Software firms show higher levels of graduate and postgraduate qualifications. The age distribution shows that software entrepreneurs are comparatively younger (31-35) than biotechnology entrepreneurs (41-45). Computer software entrepreneurs are more likely to be founders and co-founders of their businesses than the biotechnology firms. Biotechnology entrepreneurs are more likely not to be involved as the founders of the businesses they are managing currently. An overwhelming majority of software firms (67%) compared to 46% for biotechnology firms are being established as a result of individuals/group of individuals’ personal ideas. Biotechnology firms are more likely to have been created as spin-offs from universities, non-university research organisations and or parent company spin-offs. The employees’ growth shows that both groups are high growth firms and since start-up have grown considerably. These characteristics have important implications for finance.

The finance section has explored some important trends both for software and biotechnology firms mirroring the sector characteristics found in section 4.1. The refusal rates for securing funds at start-up are higher for software firms than the biotechnology firms. Software firms are comparatively growing faster than biotechnology firms and majority are at the expansion stage of business development. Biotechnology firms are showing a gradual growth but comparatively lower.

Software firms report higher financial constraints at the concept development and product development stages whilst biotechnology firms report that they were comparatively less severely finance constrained at these stages. The four main sources of funding such as VCs, BAs, banks and public sources are investing significantly more in
biotechnology firms than software firms in this study. The software firms report higher levels of difficulty in securing external sources of equity from these and such other sources. With regards to the sources of finance used, software firms reported that they have used personal sources, VC and house mortgage-re-mortgage as the principal sources of finance for their early stage of business development. Public sources such as SFLGS are used only by a small minority of software firms. Biotechnology firms on the other hand reported that the main sources of early stage funds constitute VCs and BAs as the principal sources of funding. Public sources such as SFLGS, SMART and SPUR are investing comparatively more in biotechnology firms than software firms. House mortgage-re-mortgage is not a popular source of funding at all for biotechnology firms.

These explorative findings suggest that the two sectors of HTSFs studied in this paper have distinctive features and hence may have different need for finance. This is important both for financiers and policy makers in the sense that they should be treated and understood differently. Although both sectors are high-tech and high growth firms and are birds of a feather but may not flock together.

6. References


Organising for Effective Academic Entrepreneurship

Peter van der Sijde (1, 3), Pauric McGowan (2), Theodor van de Velde (3) & Jonathan Youngleson (4)

(1) University of Twente (The Netherlands)
(2) University of Ulster (UK – Northern Ireland)
(3) Saxion University for Applied Sciences (The Netherlands)
(4) Tshwane University (South Africa)

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Abstract

The contribution has three parts. In the first part the concept of academic entrepreneurship is explained, defined and put into the context of the entrepreneurial university. In the second part four cases are described:

1. The Nikos case at the University of Twente: In Nikos teaching, research and spin-off activities are combined into one research institute.

2. The NICENT case at the University of Ulster: NICENT is set up under the Science and Enterprise Centre activities in the UK. It focuses on education and training of students (undergraduates, graduates and post-graduates) and the stimulation of academic entrepreneurship in the academic constituency.

3. The S-CIO case at Saxion Universities for Applied Sciences: In 2004 Saxion set up this Centre to have a one-stop shop for all entrepreneurial activities at the University.

4. The Chair in Technological Entrepreneurship at Tshwane University: The focus of the Chair is on education of (under)graduate students in (technological) entrepreneurship and on the stimulation of entrepreneurship in the wider community.

Each case has its own specific angle on academic entrepreneurship and in the third part the four cases are compared and analysed according to the model presented in the first part. Finally, some conclusions are formulated regarding the organisation of effective academic entrepreneurship.
1. Introduction

The entrepreneurial university is one that facilitates the creation of value for society and wealth for individuals through new and innovative undertakings. The term reflects a philosophical ‘maturation’ of the concept of entrepreneurship to include socio-economic value in addition to an association with job creation and new firm creation (Kao, 2002). This socio-economic mission is an expansion of the teaching and research missions that traditionally determined the priorities and direction of universities (Etzkowitz, 2003a). At the heart of the entrepreneurial university is innovation – what Drucker called “the effort to create purposeful, focused change in an enterprise’s economic or social potential” (Drucker, 1985, p. 67). The purpose of the entrepreneurial university is to transform academic knowledge into economic and social utility (Clarke, 1998). On the basis of a review of five leading European universities perceived as entrepreneurial, Clarke further identified pathways important for organisational transformation to be considered an entrepreneurial university:

- A strengthened steering core: an entrepreneurial university has a strong body that governs with vision and sets out a strategy.
- Boundary spanning structures (e.g. a technology transfer office) and mechanisms to interact with the “outside” world (region and industry).
- A diversified funding base: an entrepreneurial university does not entirely rely on government funding but has a balanced portfolio of first, second and third income streams.
- A strong academic heartland: inter/multi/transdisciplinary research is for a university a necessity to be among the best of universities (excellence).
- An integrated institutional entrepreneurial culture.

Etzkowitz (2003b) identifies at least five key elements of an entrepreneurial university:

- The organisation of group research (this relates in our opinion to Clark’s academic heartland).
- The creation of a research base with commercial potential (this relates also to Clark’s stimulated academic heartland).
- The development of organisational mechanisms to move research out of the university as protected intellectual property (similar as Clark’s boundary spanning structures).
- The capacity to organise firms within the university (we feel that this resembles Clark’s integrated entrepreneurial culture – in such an environment research group undertake entrepreneurial and commercial activities in one group – not necessarily under the same organisational structure).
- The integration of academic and business elements into new formats such as university-industry research centres (see our remarks above).

Explicit in Clarks characteristics and implicit in Etzkowitz is the balanced portfolio of income streams. Clark’s transformational pathways and Etzkowitz’s organisational elements are a reaction to, and to a degree influence, the changing policy perspectives of how universities are perceived in knowledge-based economies is understood. This is evidenced in recent (UK) policy reviews:

“Universities will have to get better at identifying their areas of competitive strength in research. Government will have to learn to do more to support
business – university collaboration. Business will have to learn how to exploit the innovative ideas that are being developed in the university sector” (Lambert Review of Business-University Collaboration, 2003, p. 2) “In a knowledge based economy both our economic competitiveness and improvements in our quality of life depend on the effectiveness of knowledge sharing between business and higher education” (The Future of Higher Education 2003, p.36)

Further such policy perspectives invariably translate into funding to support such policy aspirations at different levels:

- University structures and systems (UK: the Higher Education Reach out to Business and the Community initiative; Netherlands: Subsidy arrangement for Knowledge Exploitation)
- Discipline areas (UK: the Science Enterprise Challenge; Netherlands: TechnoPartner)
- Funding academic spin out firms (UK: the University Challenge Fund; Netherlands: funding of the TOP (University of Twente’s spin-off) programme by regional development funds; Germany: eXist programme)
- Supporting knowledge transfer (UK: the Teaching Company Schemes/Knowledge Transfer Schemes; Germany-NRW: Trafo programme)

2. A model for Academic Entrepreneurship

3. Four case studies

3.1 University of Twente: Nikos

The Dutch Institute for Knowledge Intensive Entrepreneurship (Nikos) is a very young research institute at the University of Twente (UT) established in 2001 and part
of the Institute for Governance Studies (one of the five focal research institutes of the UT), but it has a relatively long history. Nikos developed along two independent lines (from technology transfer and, from research and teaching) from the early 1980s on:

Technology Transfer: In the early 1980 the UT established as one of the first universities in The Netherlands and in Europe a technology transfer office. The finances for doing this came from the Ministry for Economic Affairs. This transfer office went to many organisational developments and changes. It started as the “Transfer Point” with main tasks to transfer technology to SMEs and since 1984 to spin-off companies via the Temporary Entrepreneurial Positions (TOP) programme. In 1989 the Transfer Point changed into TRD (Transfer, Research & Development) and got an extra assignment from the Executive Board to acquire (research) projects from industry. Also a group of the financial department of the UT merged into the new organisation bringing the acquisition of regional and national funds as a new task. In 1994 TRD was succeeded by the LiaisonGroup that consisted of the “old” TRD group and tasks, the Centre for Advance Education (the CPD organisation of the UT) and the newely established International Office. In 1996 the International Office split off and in 1998 the LiaisonGroup merged with the Communication Department into CENT (Communications and Transfer). In 2001 the Transfer part of CENT merged with the academic research group on entrepreneurship. It brought into the new organisation its experiences with entrepreneurship (TOP programme and international experience as consultants), regional development and technology transfer.

Research and teaching: In the mid 1980 in the Faculty Technology & Management established a centre for innovation and entrepreneurship (CIOT, Centre for Innovation and Entrepreneurship Twente) with main tasks to provide training to entrepreneurs (e.g. “Managing an SME”, the owner-managers course) and teach an elective course for students (“Become your own Boss”). It also
had a research task, but that never really got off the ground. CIOT split off from the university and merged with TSM Business School to become its Entrepreneurship Centre. The research activities remained in the Faculty and were further developed.

Dutch Institute for Knowledge Intensive Entrepreneurship
Nederlands Instituut voor Kennisintensief ondernemerschap NIKOS

NIKOS is a cooperation between the University of Twente and TSM-Business school

Activities in NIKOS

- Research
  - The role of entrepreneurial networking
  - University-Industry Interaction (ECIU)
  - E-commerce in SME’s
  - Database of knowledge intensive firms
  - Entrepreneurial career
  - High Tech Small firm Conference

- Business Development
  - University Student Enterprises
  - Regional networks
  - Incubators: TOP / Renewal enterprises
  - WAP

- Entrepreneurship in networks

- Teaching
  - Minor Entrepreneurship
  - Becoming an entrepreneur
  - Introduction to Entrepreneurship
  - Financial Management in SME’s

- Training and Consultancy
  - Market orientation HTSF
  - Supporting start ups
  - Family business centre
  - Entrepreneurial consultancy (KBO)

- Business Development Support

- Business Development Support

In 2001 Nikos was established and brought the two groups together. Nikos is active in four different areas:

- Research: Nikos’ research focuses on knowledge intensive, high-tech entrepreneurship in networks and university-industry interaction. Recently two Ph.D. projects were finished (one on the adoption of e-business by SMEs and one on global startups), four Ph.D. projects are in progress (strategic changes in the first year of high-tech companies, incubators, global startups, entrepreneurship in healthcare). Also the monitoring of high-tech ventures is an object of study.

- Teaching: Nikos teaches in both the Bachelor programme and the Master programme.
  - Bachelor programme: Nikos developed a Minor Entrepreneurship both for business and non-business students. This is a 20 ECT credit course and every student has to elect a Minor. This Minor attracts every year about 40 students and is in the top 5 of most selected Minor programmes. There also is a Bachelor programme in Advanced Technology and in this programme Nikos is responsible for a course in the first and in the second year.
  - Master programme: Nikos developed a one year Master in Innovative Entrepreneurship & Business Development (IE&BD) and has made arrangements with the University of Aalborg for a two-year Master programme. This Master programme is one of the five belonging to the Business Administration Master. IE&BD just started its first year and attracted already 20% of all registered Business Administration Master students. Nikos also delivers courses for other Master programmes: Business and IT, Industrial Design, Biomedical Technology.

- Training and Coaching: Nikos staff is also engaged in training and coaching activities in a diversity of setting. Since 8 years every year a Unispin Workshop (in cooperation with DIT – Ireland and Linkoping, Sweden) is given. Further under ProTon Europe the training is given on “Basics of Technology Transfer”. Also training activities in Russia (Moscow) are provided to a research institute.
  - Business Development: Nikos carries out the TOP programme for the UT and in the region “Achterhoek” the project “Kansrijk Eigen Baas”. In both projects Nikos staff members are consultants and actively support entrepreneurs to set up their own business. Nikos also has a task inside the university in assisting the research institutes in their commercialisation processes.
What used to be separate organisations is brought into one. Research, teaching, business development and training and coaching mutually influence each other. Most staff members are engaged in at least two or more of the activities. From the above one message should be obvious and that is that over a period of more than 20 years the UT has a rather consistent policy with respect to entrepreneurship and commercialisation of research. One aspect in this respect has not been dealt with: in the mid 1990 the UT research institutes got a more profound interest in entrepreneurship and technology transfer – they even were of the opinion that they themselves were the best to carry out these complex tasks. The research institutes did not need support but expertise. This coincided with the formation of Nikos who takes on this expert role and the research institutes of the UT (on nano/micro technology, ICT, Mechanical & Chemical engineering, and biomedical technology) all have formulated research spin-offs and technology transfer not only in their mission but also formulated annual targets (in numbers). Of course the UT has a holding company to scout and manage its IP and other interest (in the Business & Technology Centre, Business & Science Park, Knowledge Park, Venture Fund). The UT has with its spin-offs quite an impact on the region. Depending how is counted and what is counted, the UT has been instrumental in the startup of some 500 companies. The impact of this nowadays is that annually some 1000 new jobs are created by companies originating from the UT and 80% of the companies remain in the direct vicinity of the university.

3.2 The Northern Ireland Centre for Entrepreneurship (NICENT)

NICENT was established in 2000 and funded by the Office of Science and Technology (OST) in London and the regional development agency in Northern Ireland, Invest NI. It is a partnership between the University of Ulster and Queens University Belfast. Both universities have between them some 50,000 students pursuing programmes at undergraduate, postgraduate taught and postgraduate research, in Science, Engineering, Technology, Social Science, Humanities, the Arts and Business and Management. The Centre is one of 13 established under the Science Enterprise Challenge initiative set up by the UK government in order to generate a greater entrepreneurial culture within the higher education sector across the UK. The specific challenge for NICENT is to migrate entrepreneurship out of the faculties of Business and Management, where it is traditionally lodged and into the faculties of Science, Engineering and Science, (SET), where the agenda is seen as rather a novelty, and not a particularly welcome one at that.

Since the late 90s a series of government reports and strategy documents in the UK has sought to highlight the need for radical action to change the attitudes prevailing within higher education institutions with respect to entrepreneurship and to encourage a greater engagement with it. In these publications the need for culture change to one that is distinctly more entrepreneurial and that supports new venturing activity in particular has been emphasised. In addition the need to build stronger links between
the education and the business sectors has been highlighted. In such ways it is hoped to address the inherent fear of failure that so bedevils the potential for entrepreneurship in NI and to encourage greater calculated risk-taking amongst people, particularly young people living in the region.

The Centre’s efforts are first and foremost focused on curriculum development activity. Targeting specifically the faculties of Science, Engineering and Technology, (SET) the Centre has sought to embedding entrepreneurship within the curriculum at all levels of the curriculum. Recognising the pivotal role that faculty have in pushing this agenda the Centre also sought to engage the teaching and research staff within this constituency too in the entrepreneurship agenda. This has been achieved through the adoption of a series of strategies including best-practice workshops, the development of a cohort of visiting professorships in Entrepreneurship including for example the Universities of Twente and Babson, and the development of a collaborative MSC programme in Innovation and Entrepreneurship with Babson College. Other aspects of the NICENT strategy are outlined below.

Key to the success of the NICENT enterprise to date has been the support of the agenda by management at the most senior level of the partner institutions. This emphasised the importance of the agenda at the highest level and sent a clear message to course planning teams of the importance of adhering to the university’s demands for greater entrepreneurship within course documentation. A rolling programme of course review and revalidation also provided NICENT with a unique opportunity to intervene and negotiate for the introduction of the learning outcomes for entrepreneurship into course. In addition the University introduced a new policy on staff promotions that reflected the commitment by senior staff in the University of Ulster to encouraging academic members of staff to engage with the entrepreneurship agenda. As a consequence faculty member’s who engaged in pushing the entrepreneurship agenda within his or her faculty, either through teaching, research or new venturing activity, say by establishing a spin-out company, became eligible for promotion to more senior positions within the University. Performance in the arena of Academic Enterprise became a third way for faculty looking for promotion along with quality in teaching and/or research.

Other aspects of the NICENT strategy are:

*Graduate entrepreneurship:* The postgraduate constituency is probably the most likely one to provide the University with possible spinout ventures. The Centre has lately begun, through the development and presentation of specific programmes in entrepreneurship, focusing in particular on entrepreneurial new venturing, to target members of the postgraduate research constituency within the University. The programme starts with building the awareness of research students as to their entrepreneurial potential and moves to encourage them to consider in how many ways their research might have commercial value. Since starting the programme in 2003 over 150 postgraduate researcher students have undertaken the one-day programme.

*25k competition:* In addition the Centre is responsible for the management of a regional enterprise competition with financial rewards for winners totalling £25k. The competition, now in its fifth year, has attracted the entrepreneurial efforts of research staff and students from within the Science, Engineering and Technology faculties within the University. Since 2000 fifty potential new ventures have won through to the final ten of the competition, 10 in each year. Of these fifty over 20%
have continued to develop their business ideas with the help of for example UU Tech at the University of Ulster.

Corporate entrepreneurship/intrapreneurship: The Centre has developed a series of web-based programmes dedicated to challenging students at all levels to consider in how many ways they might be entrepreneurial people, to help them recognise that entrepreneurs are active in many walks of life, as new venturers, within existing businesses and within the societies and communities within which they live. Recognising that over 90% of graduates will seek gainful employment after they complete their studies; the programmes seek to develop the competencies and the willingness of students to make a difference, to take calculated risks, to “have a go”. At the University of Ulster much of this learning is web-based, student centred and designed to encourage greater independent learning. Such an enterprise for life agenda does not preclude the possibility of graduates, after some years of employment deciding to pursue a new venturing career at some later date.

As a consequence of the Centre’s efforts since 2000, a total of 4,533 students (3,903 undergraduate and 630 postgraduate), with in the faculties of Science, Engineering and Technology, (SET), have undergone an entrepreneurship programme. Each undergraduate student for example has undergone an average of 100 hours of tuition and has been formally assessed. In addition, and as a complement to the efforts of NICENT, the University is active in managing entrepreneurship apprenticeships through a government-sponsored initiative called the “Knowledge Transfer Partnership, (KTP). This programme provides students with an opportunity to undertake a two-year work-based project to resolve particular problems identified within a particular business. The student is supported and guided by both Business and University based mentors. After the two-year period the ideal solution is that the “student” has made him or herself indispensable to the business and secured permanent employment.

The Centre at the University has also developed intensive “new venture boot-camps” for members of the SET faculties as well as graduates of the University, who for different reasons have decided that they want to explore the potential of setting up a new venture based on their experience and/or research. Research Contract staff or those engaged in post-doctoral research have been a particularly fruitful constituency within the University in this regard. Graduates of the University who, because of downsizing in their company have also joined the Centre’s programmes with a view to developing new venture ideas and seeking “spin-in” opportunities.

Interaction with industry: A factor in NICENT’s success to date has been the contribution to its efforts by members of the business practitioner community. The Centre’s Advisory Board is made up of such individuals who bring a much-needed oversight to its endeavours. Members of the Advisory Board regularly contribute to programmes being developed by the Centre. In addition the Centre has utilised its relationships within the UK SEC network and with Babson College to identify programmes to which provide training to members of business community who have declared an interest in and a preparedness to contribute time and effort to the Centre in its efforts to push the entrepreneurship agenda within the SET faculties within the University. AS a consequence a cohort of adjunct faculty in entrepreneurship from amongst practitioners has begun to develop on which the Centre can call for support and guidance.
Entrepreneurship spin-offs: NICENT is first and foremost an initiative established to push the agenda for entrepreneurship through curriculum development activity, as stated earlier. Such is the infancy of the whole entrepreneurship development initiative at higher education with Northern Ireland and indeed across the UK for that matter, the raw material to support and increase the incidence of new venture starts from amongst graduates is limited. The GEM report for Northern Ireland in 2004 for example pointed out that only 5% of the NI population was engaged in entrepreneurial new venturing. NI was placed 9th out of the 12 UK regions in the entrepreneurship league table. Women were identified as being one third as likely to engage in entrepreneurial new venturing as men and “necessity entrepreneurship” in NI emerged as the highest of all the UK regions for both men and women. Fear of debt, lack of finance and fear of failure were identified as key influencers on attitudes to entrepreneurial new venturing.

The Centre through its efforts since is 2000 has sought to build the awareness of and engagement in entrepreneurship of both students, at all levels and staff. While the Centre works to push more and more students and staff into the entrepreneurial pipeline others within the University are responsible for the job of converting and supporting emerging from the pipeline with a determination to set up an entrepreneurial new venture. The primary agent for this activity within the University is the Office of Innovation and Enterprise, (OIE). A part of this Office is “UU Tech”, a company in its own right dedicated to accommodating and supporting University spinout activity. Another agent within the University is NIBEC, formed to the explore the commercialisation potential of the specific research being undertaken be a number of dedicated individuals in the area of engineering technology.

3.3 The Saxion case

A recent survey shows that the Netherlands lacks behind when it comes to starting a company; starting a company from an educational situation scores even worse. It is against this background the Ministry of Education and the Ministry of Economic Affairs made “stimulating entrepreneurship”, especially via education, a policy item in 2005. The fact that “knowledge-intensive” starters receive special attention within this policy can be explained from the fact that The Netherlands wants to improve its results as a knowledge-producing country (Lisbon Agenda). That is why there must be more innovative starters from universities and universities of applied sciences (UAS).

Competence-based UAS, an historical perspective. In the mid-nineties of the previous century the first experiments were carried out with competence-based education, a process that ran parallel with developments towards an “I”-centered society. In the preceding decade international trade and industry had started employing staff not only on the basis of diplomas but also on the basis of being able/ being willing/daring to. Staff must be competent to carry out their tasks. Competence-based thinking starts from the assumption that the “I”, as a holistically functioning and learning being, employs his knowledge, skills and attitude situationally successfully in an integral way, while reflecting on the process and the results and translating these reflections into continually changing and hopefully improving competences. Successful behaviour contains clusters of mutually and simultaneously influencing competences. This interwovenness contains the burning question of the
reliability and validity of the assessment of the competences. (Onderwijsraad, 2002), preferably in a real-life relevant context. Competence-based education acquires its concrete translation by creating a rich learning-environment in the form of projects, thematic sessions, dialogue-meetings, meetings with experts, cooperative learning, and assessment centres etc. Showing development in the ability to learn, with the help of a large variety of assessment forms, is an essential characteristic of competence-based education. The assessment of the products of acting in this way offers a good starting point to create evaluations of competences and to express them in values (credits, salary, promotion, compliments etc.)

**User-oriented learning.** In the slipstream of developments in competence-thinking in trade and industry and the numerous publications from that time, such as publications about “Recognizing qualifications acquired’ (Klarus, 1993) and “Learning in the workplace’ (Onstenk 1997) the national working-group Cooperative Learning of the UAS-Council has put competence-based thinking and competence-based organising on the UAS-map (“Handbook cooperative higher education, building-blocks for quality’, 1998). These and other signals were in themselves tangible indications that a new reality in learning, working and assessing was making its way into daily UAS practice. While at the end of the nineties professional education is cautiously embracing competence-based thinking, international trade and industry is wrestling with the transition from supply-driven to demand-driven production. And, not to be forgotten, wrestling with the consequences of globalisation. Your employer is in another part of the world! Mergers and reorganisations take place in rapid succession.

Company changes, such as Business Process Redesign (BPR), core-business thinking, lean and mean producing besiege companies. All these processes are strongly influenced by the incredible modernisation and affordability of ICT-technology. Rapidly changing demands by consumers must be dealt with adequately. Technology push and market demand are changing places all the time. The demand for a knowledge-based economy has been born. The demand for a new kind of employee and for a new kind of entrepreneur is growing. Supply-driven traditional education quickly loses touch with the acceleration in society in its demand for a new employee.

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Developments in real-world trade and industry (fig.1) are reflected in a process of Education Process Redesign (fig.2) in UAS. In 2000 trade and industry (MKB
Nederland) and UAS ( HBO Raad), together with representatives of the Ministry of Education and the Department of Trade and Industry, meet and decide on an in-depth investment in a large nation-wide experiment in which all elements of ERP (fig.2) will be given a place and a chance. The design of the curriculum, which had always been owned by the school organisation, was transferred to the owners of the learning-process, the student (being aimed at the Learning-process, individual learning-routes, user-oriented learning). In close cooperation with the work field, being the owner of a rich learning-environment (Kessels, 1998) the student learns to match his personal curriculum and the corporate curriculum (Kessels, 1998: customer relations, cooperation, flexible curriculum design and just-in-time education). This self-directed learning (Ratering and Hafkamp, 2000) is limited by the demands made by the board of examiners on the personal development plan (POP). These UAS demands originate in the Higher Education Act and in the competence profiles of the education in question. In the large nation-wide experiment “Vouchers in user-oriented cooperative learning” an important place was given to the teacher, in addition to the central role by the student. (Geerligs-Smulders 2002, 2003, 2004, De Weerd & Van der Velde 2004). The teacher promotes the changes (flexible employers) in the education. This also guaranteed direct access for the students. Representatives of the various lines of business joined them in obtaining access to the companies.

At a national level there have been extensive experiments with competence-aimed user-oriented learning and working the past 8 years (1996 – 2004) by two social interest groups, viz., MKB Nederland (the Organisation for Small and Medium-sized Companies) and the HBO-Raad (the Council of Universities of Applied Sciences), under the auspices of and financed by Ministry of Education and the Department of Trade and Industry. The outcome of these experiments has influenced the course of policies in higher education and its legislation. The new Higher Education Act will introduce competence-aimed education and user-oriented learning, with learning rights for students as a funding means. The past few decades higher education has left its solitary position in society and has more explicitly positioned itself in an open relation with its (regional) surroundings, which is considered as very desirable and as important for the development towards a knowledge-based economy. A pro-active role of the UAS towards small and medium-sized companies (trade and industry) is an indispensable link in the ‘open innovation model’ (Cherbourgh, Haour, 2004). In the ‘open innovation model’ the relation of small and medium-sized companies with institutions for knowledge has been designed in such a way that the chance of improving the innovative power of small and medium-sized companies will greatly increase. So, circulation of knowledge must be used as an intentional political strategy and it must be improved continually. After this, we will deal with developments in competence-aimed education, user-oriented cooperative learning and entrepreneurship.
The learning process in the context of society
The changes in the primary learning process have consequences for the organisation of the execution at the level of institutions, rules and arrangements in society and for the philosophical context and legislation at the policy level. “If in each of the spheres strategic choices are made in-line, the experiment can be successful”. Four themes form the red thread and the critical success factors in user-oriented learning: ownership, partnership, diversity and ability to learn. User-oriented learning means connecting learning to yourself. As the ownership increases in the governing elements in learning, such as time, speed, talent and language, learning will become more and more connected to yourself. Additional value in learning is created when learners know where to find each other, how to appreciate each other and know how to cooperate as partners in their learning process, on the basis of equality and with great respect for each other’s characteristics (Kuipers, 2004). The particular traits of people produce as many differences. Matching these differences means finding out about the power of it. This diversity is housed in the personal qualities of people, and unlocking them means growth. The ability to learn is required to make the unconscious conscious and, in that way, to make ability grow. The meaning of these four themes plays a part at all levels in the system. In the primary process learning to be an entrepreneur is taking place, the other layers of the system must create the conditions, preferably challenging conditions. How should that be achieved in large institutions of knowledge?

Stimulating entrepreneurship in general
The changing views on learning and working as a consequence of competence-based and user-oriented learning make great demands on the UAS. The changes in the primary learning process are enormous. The big UAS institutions, the result of series of mergers, are sometimes jokingly referred to as learning factories. There is an element of truth in this. Planning the learning, when, but also the speed at which, the form in which and the what, with whom and where, is for the greater part of the study determined by the institution’s teachers and managers. This present image, of the learning factory, does not seem to match the changing views on learning, leave alone the view on stimulating entrepreneurship. For entrepreneurs sense in a surprising, often inimitable way where needs arise with others. Whether it is about a basic need by people for a product or a service, an entrepreneur, being able to satisfy this need at minimal effort, gets a kick out of this, direct feedback on his good judgement and a great feeling of being useful, not only for himself but also for his immediate surroundings, his family and friends. Having a great feeling of responsibility for the effects of his actions for his direct and immediate surroundings is an integral part of his learning, curious basic attitude.
The surroundings (market, competition), not the school, dictate the speed, time, the what, the with whom and the how of learning to be an entrepreneur. All these factors have their price, a value, stakes. An entrepreneur plays (learns to play with) and controls these ingredients in his very own way. It is especially this from which being an entrepreneur derives its meaning and from which it offers a perspective on a most meaningful existence.

**Being an entrepreneur and learning in higher education.** Who is the owner of the ingredients time, speed, language and talent? To what extent is it a serious option that the UAS allows education in general, the student to retain the responsibility for learning to mix the ingredients in their own way, the ingredients that are so extremely important for learning? Are entrepreneurial competences developed in a better way and more quickly as ownership, partnership, diversity and learning ability are taken into account? Entrepreneurial competences like the power of initiative, self-confidence, motivation, creativity, perseverance, willingness to take risks, sense of realism, they will all flourish better in a learning environment with more self-control. In general, the proper or improper match between the institution’s way of determining the learning path and the student’s own possibility of determining his learning path is reflected in the number of drop-outs, low involvement, wrong choice of study/wrong diploma etc., and a low percentage of starters during and immediately after an education when it comes to stimulating entrepreneurship.

**The policy at the level of institutions, Saxion Hogescholen**

Saxon Hogescholen has translated the national policy and the experimental experiences in its strategy 2005 – 2009 (level 2 and 3, fig.3). Saxion has opted for the personal learning pathway. By means of this, the student is invited to design his curriculum himself, within the framework of a competence profile and the context of the profession he has chosen. The quality of the personal learning pathway will increase as the student seizes more ownership of his preferred context, with the speed to match, dimension of time and choosing the persons he feels he needs for coaching and assessing him. Entrepreneurship, acquiring income at your own risk and at your own expenses by offering goods or services, is such a choice for a context. Your own enterprise in a preferred context is a powerful, innovative form of the personal learning pathway, a form in which both the personal learning pathway and the link between learning and the needs of the markets (demand-driven) are given shape at the same time. Saxion’s well-intended ambition to give entrepreneurship a central position in all professional settings means, seen against the background of the above, a major operation to the very nerves of the system. The personal learning pathway offers a way out. But in order to start and nurture an enterprise more is needed than just a personal learning pathway. A change of culture is needed! The Small Business education of Saxion Hogescholen has passed on ownership of time, speed, talent etc. to the students. This extreme form of user-oriented learning scores significantly higher in the number of starters during and immediately after the study than comparable educations. In 2004 the Saxion University of Applied Sciences set up the Saxion Centre of Innovation and Entrepreneurship (S-CIO). It looks like a one-stop shop for all entrepreneurial activities. Why was it set up? What is the philosophy of the centre? How did it come to do what it is doing? Is
there a policy? Came it out of the blue or was it something inevitable when you look at the global, european and dutch social and economic signals?

The Saxion student entrepreneurs’ house
Being an entrepreneur is a mentality. Daring to run risks, being customer-oriented, getting a kick out of realizing an idea, an invention, a discovery, etc. The satisfaction of seeing other people use your service or product. The tension of continuity. Competition, the challenge to stay ahead. The loneliness when making a decision, the options. The art of growing, motivating staff, acquiring new customers. Summarizing, entrepreneurship knows its own habits, let’s say culture. It all starts with cooperation. Having good networks gets entrepreneurs on the way, they grow better and go bankrupt less often. They can organize the networking themselves but learning to network is an art. A knowledge institute can do something about this, namely facilitate a network of student entrepreneurs. Young Business Professional is a network of student entrepreneurs. They are leading in the process of developing culture. They negotiate and discuss with the Saxion Board and the province about matters that are relevant to them. Students that have not yet got that far, the budding starters benefit from being seduced into thinking about entrepreneurship. An attractive programme of meetings with entrepreneurs in the form of entrepreneur cafés, visits to companies, workshops, inspiring discussions etc. helps these students in their voyage of discovery to entrepreneurship. A certain category of early starters can borrow money at 0 % interest. In the initial growth stage seed capital is available. Obtaining coaching and training in the subject of entrepreneurship is absolutely necessary, but it should be user-oriented, not course-driven. As a knowledge institute you should know how work user-oriented if you want to coach student entrepreneurs just in time. Surveys show that in the initial growth phase a good incubator works miracles. Many forms of incubators are buildings that have especially been set up and equipped for that target group, virtual incubators and incubators in the form of accelerators in the start and growth phase, combined with fixed business models. Saxion has chosen for a mix of all this in the form of a Virtual Business Incubator. Student entrepreneurs are housed in existing companies that have square metres to spare and that make available this space, including parking places, restaurant, meeting room, secretarial office, IT-provisions etc. to this target group. The virtual skin around all these out-placed student entrepreneurs helps them with both the virtual service needed and their own network, a network of Virtual Business Incubators. The informal role of the incubatorship of the ‘mother’company is considered a very powerful form of informal coaching. Organising a structural facility provision in the organisation in the shape of the Saxion Centre for Innovation and Entrepreneurship, manned by motivated staff, is an indispensable condition for the success of the goals in the medium-long term. The Centre is an organisational instrument for the sustainable stimulation of entrepreneurship.
The “house” adapts to every environment, whether it is entrepreneurship in health care or in the engineering world, it has its function everywhere. Structural longitudinal research into the way the various elements work, apart and together, should get the function of a means of reflection when learning, thus reinforcing the learning ability of the inhabitants of the house.

**Regional and national importance.**

The provincial authorities have drawn up a ‘letter of intent’ with Saxion Hogeschoolen. In this space has been created for entrepreneurship and innovation. This administrative move is one to more administrative user-orientation. A possible consequence of this approach may be that at a regional level it will become possible to formulate an independent policy in the field of ‘education and entrepreneurship’. At a national level we see that the Ministry of Education and the Department of Trade and Industry are jointly making a case for this theme. Expert meetings and work visits at home and abroad give ministries a better idea of threats and opportunities.

### 3.4 Tshwane University of Technology, South Africa

**Background:** The National System of Innovation (NIS), as outlined in the White Paper on Science and Technology (1997) of the South African government emphasizes the importance of innovation as the underlying engine for modern economic development, and challenges the higher education system to take the lead in human capital development by equipping them with appropriate skills and competencies. The Research and Development Strategy (2002) of the Department of Science and Technology is geared to ensure a major increase in support for R&D programmes, of which the various outputs have to lead to an improvement of South Africa’s world competitiveness.

**Universities of Technology:** The fundamental mission of research universities and their academic units and programmes is the advancement of excellence in the creation, sharing and application of knowledge, typically described in terms of teaching and scholarship, research and public service or outreach. To fulfil this mission requires a distinguished faculty, high level research activities, innovative and engaging teaching-learning processes, supporting technology and quality facilities, capable students, competent faculty and staff, and effective legislative and policy support. Universities of Technology aim to further these missions by placing greater emphasis on innovation and technology transfer than traditional academic institutions. In this sense a University of Technology can be compared to an entrepreneurial university.
Tshwane University of Technology Vision and Mission
Tshwane University of Technology (TUT) was formed in January 2004 through the merger of three former technikons - Technikon Pretoria, Technikon Northern Gauteng, and Technikon Northwest. It has around 40,000 full-time and 15,000 part-time students, and about 2,000 academic staff members in 12 Faculties, and is located at 9 learning sites (Pretoria – 3 Campuses, Soshangue - 2 Campuses, Ga-Rankuwe, Polokwane, Witbank, and Nelspruit), spread over 3 Provinces (Gauteng, Northwest, and Mpumalanga) of South Africa. Its vision is ‘to be a leading higher education institution with an entrepreneurial ethos that promotes knowledge and technology, and provides professional career education of an international standard which is relevant to the needs and aspirations of South Africa’s people’. As TUT places emphasises technological innovation by making knowledge useful through focused applied research and development, a strategy for technological innovation and technology transfer was developed in support of this objective. Specific strategies to are adopted to ensure the implementation of its vision:

- The promotion and establishment of a culture for innovation and technology transfer amongst staff and students of TUT, to be measured by its incorporation into education and R&D programmes, number of patents, licenses, spinout companies and financial benefits;
- The establishment of appropriate innovation and technology transfer strategies, systems, support services, and infrastructure, to be measured by the optimal utilization of tangible intellectual assets and client satisfaction;
- The development and implementation of specific models for establishing knowledge and technology intensive enterprises, incubators, and SME technology centres, to be measured by the financial sustainability of these entities;
- The formulation of the Total Value Chain has to link with the educational programmes and R&D projects.

TUT Regional strategy: Competitive regional clusters: Capital and technology are mobile commodities, but are attracted by immobile factors such as competitive locations (modern infrastructure, strong institutions, specialized skills, clusters of enterprises, providers of business support, etc.), political stability, and absence of crime. To attract trans-national corporations or investments, competitive regional clusters should be developed. The establishment of such clusters in a region will bring benefits such as investment, job opportunities, technology transfer, new skills, and market access and will have a marked effect on regional and technological growth. Growing regional technological maturity will require that the industrial sector move from easy to complex technologies (knowledge intensive) and, within given technologies from ‘know-how’ to ‘know-why’. The raising of a region’s levels of technological development, as well as capacity development, can only be effective under the leadership of dynamic institutions specializing in technological education and transfer (technology interchange) which is the strategic direction of TUT.

Establishment and promotion of a TI&TT culture (entrepreneurial culture): Within the TUT environment the concept of entrepreneurship is not always readily accepted by academics, whereas the idea being innovative is more readily understood. For this reason TUT emphasizes being an innovative university rather than being an entrepreneurial university. The establishment and promotion of a culture for TI&TT is
a major task and needs full support from top management. The establishment and promotion of a TI&TT culture includes specific attention to the following list of requirements that need to be implemented as part of developing a culture for TI&TT:

- Awareness creation through road shows on campuses and seminars, sharing successful case studies;
- Appointment of at least one technological innovator / leader / Professor for TI&TT in each Faculty (e.g. from the CSIR, industry, SME);
- Establishing pre-incubator environments as part of culture promotion, which is a costly exercise;
- Developing educational courses / modules for students to create awareness and understanding, through exposure to successful case studies and enabling them to create ideas;
- Launching sabbaticals for staff into industry for R&D and TI&TT;
- Promoting the passion for innovation and introduce flexible management models;
- Promoting a team approach for participation in TI&TT projects;
- Marketing current projects and have an on-line showcase on projects.

**Capacity development:** A high priority is placed on building staff capacity for TI&TT as serious reservations and concerns have been raised on the current available capacity for TI&TT. This is mainly due to the existing high student: staff ratios, high teaching loads, and involvement in R&D. Capacity development entails the following:

- Launching development programmes for staff and students in which they can experience and have exposure to TI&TT needs that is closely related to R&D activities;
- Recognising the diversity of people’s capabilities in the areas of teaching and learning programmes, R&D and TI&TT;
- Identifying role models and leaders for TI&TT and appoint champions and brokers for involvement in the whole process of TI&TT;
- Appointing relevant role models as Professors for TI&TT;
- Building capacity in local communities for TI&TT.

**Learner involvement:** The strategy to involve undergraduate and postgraduate students during their formal programmes in R&D-related as well as TI&TT activities, such as laboratory work, project work in industry or community development aspects, could create an interest and enthusiasm. This entails the following:

- Integrate components of TI&TT into the curriculae at under- and postgraduate levels;
- Offering a compulsory module on TI&TT at undergraduate level as part of the teaching, learning and technology strategy;
- Exposing students to Science & Technology parks and incubators;
- Exposing learners to TI&TT activities within industry during the work integrated learning period (experiential learning).

**Creating an enabling environment:**
In order for TUT to be successful in TI&TT, an enabling environment needs to be established. The different institutional support services needs to be flexible and geared to accommodate new types of programmes, projects, and structures such as centres of excellence and incubators.
Requirements that need to be implemented as part of developing an enabling environment:

- Address the barriers of high student:staff ratios and high teaching loads, as well as administrative responsibilities;
- Establish an appropriate support service to facilitate TI&TT and the commercialization of technology process;
- Develop appropriate incentive schemes that will make it attractive for innovators and leaders in TI&TT to join and participate in this initiative;
- Develop appropriate incentive schemes for staff and students contributing to TI&TT;
- Mobilize and initialize the existing available intellectual property (IP) and products to demonstrate opportunities and potential successes;
- Establish pre-incubator environments that are conducive to TI&TT;
- Develop a sound value chain for TI&TT to cover idea to commercialization (cradle-to-grave strategy);
- Establish innovation think tanks with various partners internally and externally;

Partnership network:
Regional collaboration between higher education institutions, strong organizations, specialized skills, clusters of enterprises, providers of business support, need to be established and expanded. In the case of TUT, it has entered into joint TI&TT programmes and projects.
This entails the following requirements:

- Opportunities through national and international initiatives, such as the Innovation Fund (DST), THRIP (DTI), IFCO, GODISA, NEPAD, EU 6th and 7th Framework need to be explored and included into strategies;
- A team approach is needed for successful TI&TT, involving the different expertise needed both from within and outside TUT;
- Community involvement needs to be continuously expanded with a clear focus on a number of areas or themes;
- Establish partnerships with other higher education institutions, science councils, government and industry to optimally utilize opportunities and resources.

Management of TI&TT at TUT:
Toward the end of 2005, TUT made a strategic change in the management of R&D and TI&TT. Previously there were separate structures for managing these two functions, but from the start of 2006, TUT established a single strategy, and structures to manage the two functions, and has established a Central Research and Innovation Committee (CRIC) under the leadership of the DVC (Research, Innovation and Partnerships). Similar Faculty Research and Innovation Committees were also established. The actual management of R&D and TI&TT has been delegated to the deans of the different Faculties, under supervision of the DVC (Academic) in their line of reporting. As from the beginning of 2006, R&D and TI&TT will be referred to as Research and Innovation (R&I). The motivation for this major strategic change, is intended to support a smoother transition of research into the innovation chain for successful commercialisation of university technology.
Office for Innovation and Technology Transfer (OITT):
TUT currently has an administrative support service in the form of an Office for Innovation and Technology Transfer (OITT). The OITT is linked to the Directorate R&I. The tasks of the Office include the following:

- Provide consultancy, advice and support services on TI&TT matters;
- Suggest systems for the management of IP assets of TUT;
- Contribute to the promotion of an institutional culture for TI&TT;
- Contribute towards human potential development for TI&TT;
- Support the establishment of technology pre-incubators and incubators;
- Assist staff and students with technology-based enterprise development; and
- Assist to build international linkages in innovation and technology transfer.

The OITT aims to provide the following services:

- Assistance with identification and formal disclosure of Intellectual Property, technology assessment and evaluation and subsequent Patent registrations;
- Assistance with Business Plan development;
- Coordination of the ‘Seed Fund’ for Innovation and Technology Transfer;
- Coordination of the TUT Intellectual Property policy;
- Advisory services on matters pertaining to Intellectual Property; and
- Its subsequent transfer to Industry partners by licensing and royalty agreements;
- Coordinating the institutional part of the Innovation Fund’s National Innovation Competition (NIC);
- Assist with the monitoring licensing and royalty agreements; and
- Assist with the collection and equitable disbursement of these royalty funds due to TUT.

TUT has additional support structures and centres that form an integral part of the network and challenges for the expansion of TI&TT initiatives, including:

- On-campus pre-incubator environments;
- The UNESCO Chair in Technological Entrepreneurship;
- Centres for Entrepreneurship at various campuses.

The UNESCO Chair in Technological Entrepreneurship: Around 1997 the National Research Foundation (NRF) took a strategic decision to venture into entrepreneurship training to support a climate for development of new Small, Medium and Micro Enterprises (SMME’s). Three Chairs (Professorship) in Entrepreneurship, were established, one of which, the UNESCO Chair in Technological Entrepreneurship, is located at TUT. This decision was driven by recognition that higher education in South Africa, as a major source of developing the leaders of the future, is challenged to focus research and training activities to produce people with skills, vision and drive which are appropriate to generating socio-economic growth and development. More specifically a challenge for higher education is to contribute to the promotion and development of S&T-based enterprises/activities, with a special focus on advancing S&T-based SMME’s. It was envisaged that institutions participating in this initiative would have offices to assist researchers with commercialisation, with the development of business plans and with linkages to possible sources of venture capital funding. An agreement was reached with the University of Twente, The Netherlands, which would enable TUT to benefit from the experience gained by the European partner university.
over the 30 years in which they had been practised entrepreneurship training. The participation of South African businesses in the initiative was considered to be of key importance in ensuring that the quality and relevance of the initiative is in line with local and international market requirements. In mid-2005, the TUT Chair in Technological Entrepreneurship became the UNESCO Chair in Technological Entrepreneurship, with the signing of an agreement with UNESCO. Objective of the UNESCO Chair:

- Promote a culture of technological entrepreneurship for TUT at all graduate levels, and in the surrounding industrial and commercial community;
- Mentor and advise on strategic and operational business plan and curriculum development;
- Initiate and manage education programs and initiatives on entrepreneurship;
- Manage innovation and technology transfer activities with specific focus on Sub-Saharan Africa, by establishing suitable infrastructure and support for these activities;
- Advancing co-operation between business, academia, government and foreign expertise in the development of an entrepreneurial-minded workforce in South Africa;
- Establish and operate technology and business incubators, and assist staff and students to establish S&T-based enterprises that generate wealth and job opportunities;
- Supervise research assistants and support staff.

<table>
<thead>
<tr>
<th>Research &amp; innovation focus</th>
<th>Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive component &amp; systems manufacturing</td>
<td>CITPROD - Centre for IT Product Development</td>
</tr>
<tr>
<td>Chemical separations and spectrometry</td>
<td>Research Chairs appointed in all Faculties</td>
</tr>
<tr>
<td>Intervention technologies in Health Sciences</td>
<td>INCENTIF - Technology Incubator linked to F’SATIE (French – South Africa Technology Institute for Electronics)</td>
</tr>
<tr>
<td>Materials processing and utilization</td>
<td>Design Team Service Centre</td>
</tr>
<tr>
<td>Communication dynamics in South African performances</td>
<td>SME Technology Centre</td>
</tr>
<tr>
<td>Mathematical Technology</td>
<td>Centre for Polymer Technology</td>
</tr>
<tr>
<td>Conservation, wildlife and ecotourism management</td>
<td>SME Technology Centre</td>
</tr>
<tr>
<td>Sustainable built environments</td>
<td>Platinum Centre - Design and technology centre for platinum jewellery</td>
</tr>
<tr>
<td>Computer aided design in development</td>
<td>Chair in Technological Entrepreneurship</td>
</tr>
<tr>
<td>Pollution and waste management</td>
<td>Centre for Tissue Engineering</td>
</tr>
<tr>
<td>Electrical and electronics systems and technology</td>
<td>Chair in Automotive Engineering</td>
</tr>
<tr>
<td>Responsible tourism, hospitality and leisure</td>
<td>Centre for Tissue Engineering</td>
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<tr>
<td>Sustainable built environments</td>
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<tr>
<td>Environmental and governmental accountability for Africa</td>
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<tr>
<td>Sustainable livelihoods and poverty alleviation</td>
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<tr>
<td>Food technology and biotechnology</td>
<td></td>
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<tr>
<td>Political economy of innovation and local development</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Support structures at TUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CITPROD - Centre for IT Product Development</td>
</tr>
<tr>
<td>Technology Enterprise Centre (Soshanguve Campus)</td>
</tr>
<tr>
<td>Office for Innovation and Technology Transfer</td>
</tr>
<tr>
<td>Tshumisano Technology Stations in Electronics (Pretoria Campus), Chemicals (Ga-Rankuwa Campus) and Tooling</td>
</tr>
</tbody>
</table>
4. Comparison of the Cases & Conclusions

All cases are similar in that via all centres entrepreneurship is stimulated in the wider academic community.

All institutions have similar tasks: Nikos, Nicent, S-CIO and the Chair in Technological Entrepreneurship (CTE) have similar tasks in pushing the entrepreneurship agenda in their universities and work with students from all scientific backgrounds in their programmes. The specific target groups of students depend on the type of university and the way the centres are embedded in their universities.

All cases are different: Twente and Ulster are universities, while Tshwane is a technical university originating from three Technicons (“polytechnics”) and Saxion is a university of applied science (“polytechnic”). In Twente and Tshwane the entrepreneurship activities are carried out by academic departments, in Ulster and Saxion by administrative departments.

All universities of our case studies have adopted “entrepreneurship” as a policy item. All four universities have entrepreneurship as one of the most important policy items of the university. All universities plant and want to play a role in its (regional) context.

All institutions are embedded in a larger network of entrepreneurship activities in the university: Next to the centres that we describe in our case studies there are other units (academic and non-academic) in all universities to deal with the wider portfolio of entrepreneurial activities.

Activities carried out by the Centres:

<table>
<thead>
<tr>
<th></th>
<th>TWEN</th>
<th>ULST</th>
<th>SAXI</th>
<th>TSHW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurship: graduates &amp; students</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Unknown</td>
</tr>
<tr>
<td>Entrepreneurship: research spin-off</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>Corporate entrepreneurship</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Unknown</td>
</tr>
<tr>
<td>Intrapreneurship</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Interaction with Industry</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Activities carried out by the Universities:

<table>
<thead>
<tr>
<th></th>
<th>TWEN</th>
<th>ULST</th>
<th>SAXI</th>
<th>TSHW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurship: graduates &amp; students</td>
<td>Yes</td>
<td>Yes</td>
<td>Starting</td>
<td>Starting</td>
</tr>
<tr>
<td>Entrepreneurship: research spin-off</td>
<td>Yes</td>
<td>Yes</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Corporate entrepreneurship</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intrapreneurship</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Interaction with Industry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

5. References
[to be filled out later]
Unravelling Knowledge Networks of Urban High-Technology Firms: An Artificial Intelligence Approach

Marina van Geenhuizen, Associate Professor
Faculty of Technology, Policy and Management
Delft University of Technology,
Delft, The Netherlands, m.s.vangeenhuizen@tbm.tudelft.nl

Abstract
In urban innovation studies, much attention has been paid to benefits from local knowledge exchange for small high-technology companies. Much less attention has been given to the global pattern of knowledge networks. In this paper, we explore the spatial pattern of knowledge networks of young, innovative companies in urban areas in the Netherlands empirically, against the background of the debate about the role of spatial proximity in facilitating local knowledge exchange and learning processes. In this debate, the idea is challenged that tacit knowledge is confined to local places in providing unique advantages of knowledge spillovers to locally embedded companies. First, on the basis of conceptual notions from resource dependence theory and by using rough set analysis as a relatively new modelling approach derived from the field of artificial intelligence, we identify the factors that determine the spatial patterns of knowledge networks. Secondly, by taking the largest biotechnology cluster in the Netherlands as an example we examine to what extent companies in a clustered location employ regional and global networks and enjoy local knowledge spillovers among other agglomeration advantages.

KEY WORDS: Innovative companies, urban agglomeration advantages, knowledge networks, rough set analysis, biotechnology, the Netherlands.
1. DRIVERS OF THE URBAN ECONOMY AND PROXIMITY

It is common place that the capability to produce and utilize new knowledge is the most important asset of developed economies in Western Europe in their attempts to innovate and remain competitive. A major explanation for today’s attention for this capability is the increased mobility of capital and labour, in a world in which modern traffic and communication technology and the disappearance of particular borders have led to an increased global competition (OECD, 1996). More specifically, it is the lagging behind of European countries in terms of major economic indicators, compared with emerging Asian economies and the US. In this context, new knowledge not only refers to new products and processes, but also to new markets and management models.

In recent studies on innovation of urban economies much attention has been paid to knowledge as an important component of agglomeration advantages. Companies that are drivers of the urban economy, that is young and competitive ones creating new jobs on the basis of information and communication technology (ICT), multimedia, biotechnology, material science, optics, laser technology, etc. are often seen as enjoying the benefits from locally embedded knowledge networks in their urban production environment. In this vein, cities provide advantages of knowledge spillover effects and an abundant availability of knowledge workers in the labour market (Acs, 2002; Audretch, 2000). Spatial concentration of similar and/or dissimilar activities increases the opportunities for interaction and knowledge transfer, and the resulting spillover effects reduce the cost of obtaining new knowledge. In addition, knowledge workers preferably interact with each other in agglomerated environments to reduce interaction costs, and they are more productive in such environments (Florida, 2002). The facilitation of face-to-face contacts and repeated meetings in person by spatial proximity and the limits to this by particular geographic borders, e.g. of a daily activity system or central business district, are central in the arguments of some authors to view tacit knowledge transfer and knowledge spillovers as being confined to local agglomerated environments (e.g. Maskell and Malmberg, 1999; Storper and Scott, 1995; Rosenthal and Strange, 2001). An exclusive availability of tacit knowledge and knowledge spillovers has been proposed – in urban agglomeration and cluster approaches - as the main mechanism that makes it beneficial for companies to be located in agglomerated urban areas and spatial clusters.

By contrast, much less attention has been given to global patterns of knowledge creation and use - like in biotechnology and nanotechnology. It is often overlooked that the need for high levels of competence and specialization may urge knowledge workers to participate in knowledge networks within strategic alliances across the globe on the basis of face-to-face contact. Also, the position as a subsidiary of a foreign mother company may cause a frequent participation in knowledge networks abroad. The attention for achieving tacit knowledge at distant places, through personal visits or detach of knowledge workers, is relatively new (e.g. Rutten and Boekema, 2004; Doornbos, 2005) and puts an emphasis on access of urban places to an international airport (Simmie and Sennett, 1999). The crucial condition in the exchange of diffuse and tacit knowledge in this view is a similar social context of the partners involved, determining a proper understanding and interpretation of the knowledge. There are some recent attempts to connect the two views and understand the conditions under which knowledge is exchanged locally and globally (e.g. Bathelt et al., 2004). This paper fits into this recent trend. Accordingly, the aim of this paper is to explore and understand the spatial layout of knowledge networks and benefits from knowledge spillovers and other
agglomeration advantages of innovative companies in urban places. To this purpose, we examine the following questions: (1) To what extent are urban innovative companies utilizing regional and global networks in knowledge exchange and learning? (2) What factors determine the spatial layout of these networks? (3) What is the importance of local knowledge spillovers among other advantages of an agglomerated location?

The structure of the paper is as follows. We first address notions from resource dependence theory to better understand the needs of young, innovative companies, and pay attention to some theoretical aspects of knowledge networks (section 2). This is followed by a discussion of the research design, particularly the use of rough set analysis (section 3). Next is the interpretation of empirical results on the spatial layout of knowledge networks (section 4) and a more in-depth analysis using a case study of clustered biotechnology companies (section 5). The paper concludes with a summary and evaluation of the empirical results in the light of the debate, and indicates some future research paths.

2. A BRIEF THEORETICAL INTRODUCTION

In this section we briefly discuss some essential notions from resource dependence theory, particularly to increase understanding of inter-firm differences in opportunities and sets of resources among young, innovative companies (Barney, 1991; Reid and Garnsey, 1998; Richardson, 1972). In addition we focus on theoretical aspects of networks and knowledge networks, as a specific kind of resource.

In modern versions of resource dependence theory companies are seen as bundles of resources with their long-term competitiveness resting in resource configurations that managers build. Companies make use of various combinations of resources (bundles) on a temporary base, like knowledge, capital, employees and networks, and their success depends on their capability to match opportunities with the development of own resources or disclosure of external resources. Growth is constrained if there is a shortage or weakness in the companies’ capability to generate internal resources and if companies lack the capability to disclose external resources. With regard to the growth of young, high-tech companies, Reid and Garnsey (1998) distinguish between three different stages, running from achieving access to resources, mobilisation of resources, to the own generation of resources. Knowledge is a critical resource in all three stages, including knowledge on commercial opportunities, on the business start-up process, and on business development, marketing and finance, respectively.

Knowledge is not only about know-what and know-how, but also know-who and know-why (e.g. Lundvall and Johnson, 1994). This classification of subject matter is often associated with different types of knowledge in terms of codification and transferability (e.g. Gorman, 2002). Accordingly, know-what and know-why mainly refer to codified knowledge found in manuals, data-basis, and conference proceedings, etc., whereas know-who and know-how are mainly connected with practical experience, learning-by-doing and social interaction including the transfer of tacit knowledge. Unlike codified knowledge, the creation and use of tacit knowledge is strongly dependent upon the social and organizational context that determines - through shared beliefs, perceptions and experiences – understanding and interpretation (e.g. Gertler, 2003). Note that the various types of knowledge do not work separately, but interact in processes of learning. For example, tacit knowledge is necessary to understand codified knowledge.
The use of the right combination of resources at the right time enables companies to undertake a jump in their growth (next development stage) (Vohora et al., 2004). Most recently, a stronger emphasis is put on heterogeneity between high-technology start-ups at their start in terms of opportunities and resource requirements, e.g. following from a different position of the entrepreneur, a different corporate position (independent company, support form mother company, etc.) and different main activities, like contract R&D, in-house basic research and technical services (e.g. Druilhe and Garnsey, 2004).

Networks can be seen as a specific external source of resources that may be utilized to exploit opportunities (e.g. Brush, 2001). Analysing entrepreneurship from a network perspective has become quite fashionable since the mid 1980s in organizational and economic studies (e.g. Borgatti and Foster, 2003; Hoang and Antoncic, 2002; Kamann, 1989). Networks can be perceived as a set of actors connected by a set of ties, the former including persons, teams or organisations (Granovetter, 1973). Companies establish networks or they decide to participate in existing networks if the perceived benefits outweigh the costs concerned. To achieve the best knowledge may be the main purpose of a network (e.g. a strategic alliance on R&D) or is a positive side-effect of other networks, like the ones with customers in which products or processes are adapted on customer demand. Networks face many dimensions aside from their spatial layout (e.g. Hoang and Antoncic, 2002; Kamann, 1989):

- tightness of the ties, like loosely coupled or tightly coupled ones;
- strength of the ties, like strong or weak ties;
- directed or non-directed ties, like a personal advice to a network member, or shared facilities for all members due to e.g. physical proximity;
- structure of the network, like one-to-one networks and multiple focal networks;
- stability, like temporary networks and (semi) permanent networks;
- a set of other characteristics, like level of institutionalisation, hierarchy involved, symmetry involved, formal nature, etc.

Knowledge networks face all the above dimensions and differences. For example, knowledge networks in medical biotechnology may encompass rather long lasting, one-to-one relations in research project and employ knowledge exchange in a formalized manner. By contrast, networks in software design may be equally one-to-one, but last for just one design project, and the knowledge may be highly diffuse and tacit e.g. to solve badly structured customer problems. The above notions and views call for a thorough empirical investigation. The next section discusses the design of the empirical study.

3. RESEARCH DESIGN

The research design of this study employs an inductive approach using a limited number of carefully selected case studies. The case study design permits a logic in the sense of “replication”, allowing the case analysis to be treated as a series of independent experiments (Yin, 1994).

The study utilised a detailed field study of 21 young, innovative companies in the Netherlands, selected from biotechnology, ICT-services and mechatronics (optronics). Data were derived from face-to-face interviews with corporate managers and, additionally, from web presentation and annual reports of companies, and from branch reports and journals of the various sectors. The research design required the use of a semi-structured questionnaire in
the interviews, to produce both scores in a standardised way and in-depth insights; the latter to
obtain a rich understanding of the spatial knowledge network and relevance of international
airports on the individual level. The research design also implied that companies were
selected to contain a substantial degree of variance on dimensions that are relevant from a
resource-dependence perspective, e.g. company size, position and degree of innovativeness.
For example, in the biotechnology sector we selected genuine research companies (long
development paths of new medicines), companies involved in tool development (platform
technologies), and service companies (shorter innovation projects) (Biopartner, 2002).

Information from the semi-structured interviews was used to develop a database as a matrix of
objects (companies) that constitutes a concise representation of the underlying field
information: the information table. We developed such a table (see Appendix 1), i.e. to serve
as a basis for a systematic analysis of knowledge networks and determining factors. In our
study, conventional statistical analysis (such as multiple regression analysis or discrete choice
modelling) could not be applied because of the low level of measurement of some variables
(categorical) and the small sample. We, therefore, made use of another technique that has
increased in attention in the past years as a pattern recognition or classification technique, i.e.
rough set analysis (e.g. Pawlak, 1991; for details, Polkowski and Stolron, 1998). An
additional advantage is that in rough set analysis - unlike more conventional methods – only
one assumption is made about the data, i.e. that the value of the determining factors can be
categorized. Rough set analysis works as follows. If in a causal investigation a distinction can
be made between stimuli (condition variables) and response (decision variable), then rough
set analysis is able to identify causal linkages between classified conditions and decision
variables. In our analysis we are particularly interested in the decision algorithms produced by
a stepwise scanning of the data-matrix. These contain conditional statements of an “if ......,
then ......” nature. Accordingly, we can identify which conditions (combinations of attributes
of the conditional variables) lead – in a logic deterministic way - to a particular state of the
decision variable. The decision variable in our study is the spatial pattern of knowledge
networks. A useful computer software programme to carry out a rough set analysis is Rough
Set Data Explorer (ROSE). This algorithm constructs the best possible decision rules to
explain the frequency of occurrence of features. Further details can be found in the
aforementioned references.

Knowledge networks were measured as “relations dealing with knowledge”, e.g. concerning
personal networks of the manager (CEO), customers, suppliers, knowledge institutes, alliance
partners, head office, etc. In our approach of emphasizing interpersonal networks, tacit
knowledge forms a substantial part of the knowledge concerned. In addition, the more stable
relations were included. The knowledge relations identified could cover ego-centred networks
(like between the company and a research group at the university in a dedicated project) as
well as multiple focus networks (like between the company and customers with multiple
customer relations). We have measured the spatial pattern of knowledge networks on the basis
of revealed preference, i.e. the most important current knowledge sources for innovative
activities and the location of the relationships involved. We could have chosen other ways to
measure knowledge relations (networks), e.g. on the basis of joint patent applications or
patent citations, but this would have narrowed our scope because much knowledge exchange
(and spillovers) happens independent of patent activity.

The condition attributes were selected on the basis of the previously indicated resource-based
approach. Accordingly, these attributes refer to a different profile of companies in terms of
knowledge requirements and access to external knowledge, such as current position (spin-off,
subsidiary, independent, etc) and age. With regard to the latter, we wanted to capture really young companies, still vulnerable for some starting-up failures, and older ones that survived this period (but not older than 15 years). We also included size of the company, main activity (manufacturing or services) and development time of innovations. Using the latter, we attempted to capture different levels of innovativeness and related knowledge requirements. As an indicator for the level of innovativeness, we could also have taken the number of granted patents. However, patenting as a strategy to protect intellectual ownership is less common in services than in manufacturing and would have given a wrong impression of innovative activity in services. Furthermore, we added the generic spatial orientation of the company, as measured based on the company’s dominant supplier and customer relationships. The condition attributes can be summarized as follows: 1) corporate position (status); 2) age; 3) size (employment); 4) main activity; 5) development time of innovations; 6) general spatial orientation.

The rough set procedure provides results that assess the quality of the data (condition variables and dependent variable) in the information table. First, each estimation produces a distinction between “core variables” and other variables. If all condition variables belong to the core, then the conclusion can be drawn that all these variables contribute to an explanation and no variable gives redundant information. In our analysis, all but one condition variable belong to the core. The quality reaches the value of 1.0, meaning that the reliability of the classification for the dependent variable and the overall quality of the information table are at their maximum (see Appendix 2). Further, each rough set analysis produces a number of decision rules and for each rule the concomitant coverage (in percentages). The coverage is an indicator of the strength of the rule, calculated as the share of the cases with a similar set of attributes and score on the decision variable divided by all cases with this score on the decision variable. The highest level reached in our analysis is 41.7% (5/12). Another indicator that can be used in the interpretation of rough set results is the frequency in which a condition variable is included in the set of rules. Note that the interpretation of the results of the rough set analysis is valid to the extent in which the case studies selected provide a fair representation of young, innovative, companies located in the major city-regions in the Netherlands. In the next section we proceed with a discussion of the rough set results.

4. SPATIAL LAYOUT OF KNOWLEDGE NETWORKS

We present the results of a comparative analysis of the companies in two parts. First, we discuss the different spatial patterns of the knowledge networks and secondly, we examine the results of the rough set analysis in explaining these patterns.

We have determined the spatial layout of the knowledge networks on the basis of the location of each of eight relevant knowledge sources for innovative activities, i.e. personal networks, customers, suppliers, universities (other knowledge institutes), partners in alliance, other parts of company (mother company, subsidiaries), conferences and fairs. A company was classified “mainly regional” if the share of regional networks is larger than the share of global networks, and “mainly global” if the share of global networks is larger than the share of regional networks. We adopted this classification because a more refined classification would have led to more classes (note 1). Four or five classes would have rendered rough set analysis as a broad pattern recognition technique less useful.
Table 1 shows the characteristics of the sample in terms of the spatial layout of the knowledge networks. First, it appears that particular segments of young innovative companies in urban areas employ mainly regional networks while other segments employ mainly global networks. There is thus clearly a trend for co-existence. Secondly, the global networks seem to have developed in a more pronounced way compared with the regional networks, witness the differences in maximum shares (100 versus 58%).

**Table 1 Descriptive statistics of knowledge networks a)**

<table>
<thead>
<tr>
<th></th>
<th>Mainly regional</th>
<th>Mainly global</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nr of companies</td>
<td>9</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Average share of region (%)</td>
<td>38</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>Max share of region (%)</td>
<td>58</td>
<td>-</td>
<td>58</td>
</tr>
<tr>
<td>Average share of global (%)</td>
<td>-</td>
<td>57</td>
<td>38</td>
</tr>
<tr>
<td>Max share of global (%)</td>
<td>-</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

a) 21 case studies

The application of the rough set methodology has led to a set of eleven decision rules referring to the above two classes of spatial layout. In the remaining section, we limit our discussion to eight rules that are solid in that they cover companies not subject to an exceptional situation (ICT crisis). The results can be summarized as follows (Table 2, see, also Appendix 2):

1. Two factors have a strong influence on the spatial layout of knowledge networks, i.e. position (status) and general spatial orientation (customers/suppliers). Other factors derived from resource dependence theory, like age and size, are less important.
2. If we focus in on global networks, the most determining factors are position (status) and duration of innovation projects. This points to an important influence of corporate ownership relations and the level of innovativeness (specialization). The knowledge networks mainly include worldwide customers and research alliances.
3. A relatively strong rule is Rule 7, referring to global networks and covering 5 companies (41.7%). This rule is particularly strong because it includes companies from different sectors (biotechnology research and advanced optronics development and manufacturing). In addition, a closer look reveals that the companies are rather homogeneous in share of global networks, i.e. a range between 42 to 70%.
4. If we consider how the rules relate to economic (sub)sectors, it becomes clear that all the three sectors (ICT services, biotechnology and optronics industry) are present in both classes, pointing to a weak importance of the sector.

We may conclude that young, innovative companies in urban regions tend to derive essential knowledge only partly from this region. Broadly, there are two segments: (a) companies with a predominantly regional network based on strong knowledge ties with local customers or suppliers and (partly) advanced ICT facilities, and (b) companies with a predominantly global network influenced by network configurations of the mother company or company of origin, or a high level of innovativeness (specialization) urging to connect globally.
### Table 2 Rough set results on the spatial layout of knowledge networks

<table>
<thead>
<tr>
<th>Condition variables</th>
<th>Nr of cases and strength of rules</th>
<th>Rules and additional information (italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mainly Regional</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Size and general spatial orientation | 2 (22.2%) | Rule 1: Medium-sized/larger and a local orientation  
ICT services (specialized call centres and IT facility providers) |
| Position and general spatial orientation | 2 (22.2%) | Rule 2: Independent position and local orientation  
Services in biotechnology (testing) |
| Position and duration of innovation projects | 2 (22.2%) | Rule 3: Academic spin-off and short lasting innovation projects  
Non-standard ICT services |
| Age, main activity type, general spatial orientation | 2 (22.2%) | Rule 4: Young manufacturing companies without preference in orientation  
Young companies in advanced optronics industry in stage of (re)start |
| **Mainly Global** |                                   |                                           |
| Position and general spatial orientation | 3 (25.0%) | Rule 5: Independent or foreign subsidiary, without preference in orientation  
ICT services and engineering services |
| Position and main activity type | 1 (8.3%) | Rule 6: Corporate spin-off and providing services  
Advanced biotechnology services (process optimisation) and network from multinational (origin) |
| Age and duration of innovation projects | 5 (41.7%) | Rule 7: Older age and (very) long lasting innovation projects  
Biotechnology research and advanced optronics development |
| Age and general spatial orientation | 2 (16.7%) | Rule 8: Young age and global orientation  
Biotechnology research (foreign subsidiary) and ICT services (digital protection software design) |

Source: Adapted from van Geenhuizen, 2005.

In a next step, we attempt – as a preliminary experiment - to apply the rules derived from the rough set analysis to a small population of companies.

### 5. KNOWLEDGE NETWORKS IN A BIOTECHNOLOGY CLUSTER

In order to apply the above rules to a small, clustered, population of companies, we have selected the biotechnology sector and one particular cluster in the Netherlands, i.e. the region of Leiden. In order to find data concerning the condition attributes, we made use of sector reports on biotechnology in which most companies are listed (Biopartner, 2003, 2004; Holland Biotechnology, 2003). Official statistics could not be used because medical
biotechnology – the specialization of the cluster in Leiden - is not clearly visible or dispersed in such statistics.

The biotechnology cluster of Leiden is located in-between the agglomerations of The Hague and Amsterdam. Its origin goes back to the early 1980s. Driven by the inspiration of some leading academics (molecular biology) and visionary views of local policymakers in the early 1980s, the municipality opened the Bio-Science Park in 1984, including an incubator facility as a joint initiative with the university. Growth of the park took off almost immediately, after the establishment of a subsidiary of US-based Centocor in 1985. Early 2004, the number of biotechnology companies amounted to about 30, including young entrepreneurial companies and foreign subsidiaries, but excluding consultancy companies and traditional pharmaceutical industry. The knowledge institutes in the cluster encompass various faculties of the State University of Leiden (including its medical school and academic hospital), the Higher Educational Institute Leiden, the Leiden School for Instruments Design, TNO Applied Sciences in Prevention and Health, the Center for Human Drug Research (clinical research cooperation of the universities of Leiden and Amsterdam), and the Center for Medical Systems Biology (Genomics). Delft University of Technology (about 30 km South) provides hard-core technology, like in bio-process technology, and is involved in joint educational programs with the University of Leiden in life sciences.

Our assumption in the application of the rough set rules to companies clustered in Leiden is that the predictive power of the rules is 100%. Of course, the predictive power is lower. In other research, based on additional random samples drawn from the base population the accuracy in predicting the outcomes on the decision variable by information from the rules amounts to 75 and 87%, indicating a sufficient level of robustness (Goh and Law, 2003; Soetanto and Van Geenhuizen, 2005). In such extension of the analysis data need to be available for many more objects than merely those in the selected sample, which may hinder such approach. Further, in terms of difficulties encountered in classifying the companies according to the rules, we need to mention the following. First, information on the general orientation of companies, based on dominant supplier - and customer relations, is often not available in sector reports. In this respect, the information is derived from company websites and annual reports. Secondly, the main activity, e.g. research, services, manufacturing, is increasingly difficult to determine, due to a move by the companies to more hybrid models (Biopartner, 2004).

Given the above assumption and limitations, the knowledge networks in the biotechnology cluster in Leiden appear to be predominantly global in terms of employment concerned (91%) and but for a large part (56%) local in terms of number of companies (Table 3). This picture follows from a skewed size distribution of companies in the cluster, with a large number of small companies and a small number of large (often global) companies. In the remaining section, we discuss the outcomes of an in-depth analysis of biotechnology companies in the cluster of Leiden, to clarify this situation and connect networks to knowledge flows by using a more dynamic perspective (Cooke, 2004). In this perspective, a distinction is made between origin of the knowledge and check on viability (including the start-up company), and the stages of exploration, examination and exploitation, and places where the knowledge runs through these stages.
Table 3 Spatial knowledge networks in the cluster of Leiden (based on estimations)

<table>
<thead>
<tr>
<th>Decisive company attributes</th>
<th>Dominant layout</th>
<th>Number of companies a)</th>
<th>Number of knowledge workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services, independently established, general regional focus</td>
<td>local</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Research, very young start-ups (academic spin-offs)</td>
<td>local</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>Research, somewhat older age, and long-lasting innovation projects</td>
<td>global</td>
<td>8</td>
<td>405</td>
</tr>
<tr>
<td>Advanced services, general global focus</td>
<td>global</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Foreign subsidiaries</td>
<td>global</td>
<td>3</td>
<td>+/- 800 b)</td>
</tr>
<tr>
<td>** Totals (% share) **</td>
<td>local</td>
<td>15 (56%)</td>
<td>125 (9%)</td>
</tr>
<tr>
<td></td>
<td>global</td>
<td>12 (44%)</td>
<td>1,235 (91%)</td>
</tr>
</tbody>
</table>

a) Excluded are traditional pharmaceutical companies and consultancy.

b) The share of biotechnology knowledge workers in standardized production plants (mainly in Centocor) is estimated at 70%.

If we focus on research companies for which projects often last 10-15 years including testing and approval of new drugs and diagnostics - the following becomes clear. The viability of a new idea upon which spin-off companies from the university or academic hospital are based, is examined and checked locally in the cluster of Leiden. The new idea itself, however, may not originate exclusively from this cluster but also from nearby clusters (Amsterdam, Utrecht). In terms of advantages, start-up companies benefit from cheap and flexible laboratory room in incubators, shared facilities, easy contact with the medical school, academic hospital, and university, and a pool of specialized workers. Local knowledge spillovers play a crucial role in this stage. In the next stages, however, a further exploration and examination of the new knowledge increasingly take place outside the cluster of Leiden, in broader, mainly global networks, including big pharmaceutical industry and collaboration with medical schools, academic hospitals and research institutes. For example, development programs of Crucell include collaborations with Aventis Pasteur, the US National Institute of Health, GlaxoSmithKline and New York University. Accordingly, the knowledge networks have broadened and advantages now include easy access to the international airport of Amsterdam Schiphol (15-20 minutes time-distance from Leiden) and access to a supercomputer. In these stages, a pool of specialized labour is only important if the company grows locally. Note that there are also some practical economies, i.e. services derived from nearby biotechnology service companies and the potential to pool laboratory facilities (e.g. clean rooms and breeding facility) and laboratory workers (analysts) during peak demand with a few neighbouring companies. Finally, the check for exploitation of the new knowledge also mainly occurs outside the Netherlands in global networks, in which big pharmaceutical and larger biotechnology companies dominate due to their marketing power.

What causes the above need to connect with global knowledge networks after a few years of existence, is the fact that in the cluster of Leiden - but also in a larger area, including the biotechnology clusters of Amsterdam and Utrecht – a strong basis of leading pharmaceutical and leading biotechnology companies is missing. The pharmaceutical companies here mainly
produce generics or engage in standard production and packing of drugs, meaning a lower level of innovation and less interest in developing new drugs and diagnostics based on biotechnology. The biotechnology research companies in this region seem not sufficiently strong to take responsibility for the stage of exploration and the stage of testing and (clinical) trials. This situation makes the difference with what Cooke (2004) names “biotechnology megacentres”, like Boston, Cambridge (UK) and eventually Munich. However, the future for Dutch small biotechnology business is not that bleak. One of the Netherlands pharmaceutical/chemical companies is now quickly developing biotechnology as a core business and eager to cooperate with small companies in medical and food biotechnology, and that is DSM. Most recently, Leiden-based Crucell and Limburg-based DSM started cooperation.

The above spatial pattern of knowledge exchange among research companies is clearly different from the pattern among independent service companies, like the ones providing standard and customized testing (e.g. DNA sequencing; cleaning and validation studies). The knowledge involved has already successfully captured a place in the market and the knowledge networks are mainly regional on the basis of relationships with customers. Innovation has a different meaning here: mostly incremental improvements in testing and determination techniques on the basis of specific customer demand. Accordingly, local knowledge spillovers in the relation to customers matter for these companies. Other advantages of an agglomerated location include use of incubator facilities (start-up stage) and the potential of pooling capacity with selected neighbour companies. There is one type of service companies that does not fit into this picture, i.e. the one of which the networks have been modelled by an internationally oriented mother company. Most of the service companies in Leiden, however, do not match with this category.

We may conclude so far that in the start-up stage of biotechnology companies concerning drugs (diagnostics), local agglomeration advantages like knowledge spillovers from the local university and hospital are highly important. However, as soon as the knowledge networks become global after a few years, such local economies disappear and make place for easy access to global networks (mainly Amsterdam Schiphol Airport) and nearby (routine) knowledge services. The local knowledge institutes (university hospital, medical school, faculties) then become part of a larger, national and international network. This picture complies with some other recent research outcomes, indicating that overall, the local university (medical school) is not the prime source of information for clustered companies as the knowledge comes from more distance places (e.g. Lawton-Smith, 2004; McKelvey, 2004).

6. CONCLUDING REMARKS

The aim of this study was to increase understanding of the spatial dimension of networks through which young innovative companies located in urban areas create and exchange new knowledge. The theme fits into the debate about the importance of physical proximity in knowledge exchange, i.e. a crucial role in facilitating tacit knowledge transfer, versus no crucial role, but prime importance for social and organizational proximity, and concomitantly local knowledge networks versus co-existence of local and global networks. The results of this study support the idea of co-existence. In urban areas in the Netherlands we find segments of companies that have a global focus in their knowledge networks and segments that have a local (regional) focus. Furthermore, in a case study of a specific cluster –
biotechnology – we found a predominantly global focus based on employment data. Physical proximity (including local knowledge spillovers) in this cluster only matters in the context of spin-off processes from local knowledge institutes and in knowledge relations of service companies in the cluster. Partly, this situation can be ascribed to the absence in the cluster of pharmaceutical industry with which can be connected as well as the absence of a strong basis of regional biotechnology companies that can take the responsibility for further stages in the knowledge value chain, i.e. exploration, examination and exploitation of the new knowledge. Accordingly, connecting with global networks is a must for research companies after a couple of years.

Further research follows from the specific design of the current study. There is a need to carry out in-depth studies of the clusters that were only included in the rough-set analysis, e.g. ICT and mechatronics (optics) and to compare with biotechnology in terms of background to the regional and global networks, particularly how the new knowledge arises and where it is explored, examined and utilized. Another research line is methodological and concerned with the opportunities of rough set analysis. In our research design, we used a selected sample representative for particular types of companies. This means that the results cannot be generalised statistically. It would be interesting to undertake the selective sampling as a part of or partly aside from some random sampling, such that a connection (overlap) can be established between the random samples and the outcomes of rough set analysis (decision rules) can be randomised for a population. Such smart research designs (pooled structure) would then open ways to advanced modelling.

Acknowledgement
This paper benefits from support from TU Delft, as a part of the Spearhead Research Program “Sustainable Urban Areas” and from a grant of the Dutch National Science Foundation (project number: 014-43-616-P).

Note 1
We could have distinguished a third class: both regional and global companies. However, there were only two companies for which the share of the regional network and that of the global network were approximately equal in size.

References


Appendix 1. Structure of an information table (two hypothetical examples) a)

<table>
<thead>
<tr>
<th>Objects</th>
<th>C₁</th>
<th>C₂</th>
<th>C₃</th>
<th>C₄</th>
<th>C₅</th>
<th>C₆</th>
<th>Decision variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Position</td>
<td>Age</td>
<td>Size</td>
<td>Main activity</td>
<td>Duration innovation projects</td>
<td>General spatial orientation</td>
<td>Spatial layout</td>
</tr>
<tr>
<td>O₁</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1= Local/Regional</td>
</tr>
<tr>
<td>O₂</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2 = Global</td>
</tr>
</tbody>
</table>

a) C₁-C₆: condition variables
b) O₁-O₂: companies

Appendix 2. Summary of results of the rough set analysis

<table>
<thead>
<tr>
<th>Condition variable</th>
<th>Decision variable: regional/global knowledge networks</th>
<th>Frequency (in 11 decision rules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Position</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>1.2 Age</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>1.3 Size</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>1.4 Main activity (industry, services)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>1.5 Duration of innovation projects</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>1.6 General spatial orientation</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

Indicators of strength information table

| Number of core variables | 5 out of 6 |
| Quality of the core     | 1.0         |

Indicator of strength of results

| Maximum coverage of rules | 41.7% |
| Coverage of majority of rules (4) | 22.2% |
THE EFFECT OF A BIOTECHNOLOGY SMES’ NETWORK POSITION ON ITS INNOVATIVE PERFORMANCE

Work in progress paper, not to be cited.

Lobke Vanhees
Hasselt University
Department of Business Administration
Faculty of Applied Economics
Agoralaan - gebouw D
B-3590 Diepenbeek
tel.: +32 11 26 86 15
fax: +32 11 26 87 00
e-mail: lobke.vanhees@uhasselt.be

Supervisors: Prof. dr. W. Voordeckers, Hasselt University
Prof. dr. J. Hagedoorn, Maastricht University
dr. A. Van Gils, Maastricht University
ABSTRACT- This research paper studies the importance of an SME’s network position within the biotechnology industry, and the effect of it on its innovative performance. We developed theoretical propositions departing from the resource based view and network theory. We argue that a firm’s position within an SME network will have an influence on the innovation output. The more R&D collaboration a small biotech firm has with other SMEs in the biotech sector, the greater the subsequent innovation output of the firm. We also argue that centrality within the network matters. These propositions will be tested using a dataset we are constructing. We used the MERIT-CATI database to select companies that formed inter-firm R&D collaborations during the period 1990-2000 in the pharmaceutical biotechnology industry. We are linking innovation measures to the firms of these R&D alliances.

1. Introduction

This research paper studies the importance of an SME’s network position within the biotechnology sector, and the effect of it on its innovative performance. The pharmaceutical biotechnology industry is a rapidly-developing field where the knowledge base is both complex and expanding and the sources of expertise are widely dispersed (Powell, 1998). Firms operating in this sector face two major challenges. First, industries like biotech are characterized by ever-shortening technology development cycles, long product development cycles, but short product cycles. This forms a constant pressure on companies to respond quickly to changing market needs and to new technological opportunities. The survival of the companies depends on the maintenance of a competitive position, which on its turn is determined by the rate of innovation. To stay on top of the field, one has to be at the forefront of knowledge seeking and technology development. (Oliver & Liebeskind, 1997). A second challenge is related to the resources and capabilities available to the firm’s operating within this industry. Biotechnology is a field where all the relevant capabilities are rarely found under a single organization roof (Powell & Brantley, 1992). While the basic and applied research skills needed to create new products are based in universities, research institutes, and biotech companies, the cash necessary for product development, the experience required in launching extensive clinical trials, and the established, world-wide marketing channels are located in large chemical and pharmaceutical companies. To make up for their lack of internal capabilities, the participants have to turn to cooperation (Powell, 1996).

Small firms within the biotechnology industry are faced with more specific challenges. They have a lot to offer regarding research and new technologies but they lack the competences to commercialize the new drugs successfully. They are often innovative but fail to provide the entire set of business functions along the value chain. They suffer from insufficient management skills and lack production, marketing and production expertise (Shan et al 1994; Powell 1998; Gulati & Gargiulo, 1999, Roijakkers et al 2005, McCutchen & Swamidass, 2004, Audretsch & Feldman, 2003, Pfirrmann, 1998). Most of the small biotech firms are driven by innovations and laboratory discoveries in a single therapeutic area, the resulting cash-flow problems pose severe financial limitations on the companies (Oliver & Liebeskind, 1997). Academic researchers (Senker & Sharp, 1997; McCutchen & Swamidass, 2004; Roijakkers et al 2005; Hagedoorn et al 2005; Powell, 1996; Baum, Calabrese & Silverman, 2000) have illustrated that small biotech firms engage in diverse linkages with large pharmaceutical firms, university and research centres and other small biotech firms to overcome these problems. According to Powell (1996), networks serve as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable.
So far, numerous studies have been published studying alliances between pharmaceutical firms and small biotechnology firms (Senker & Sharp, 1997; McCutchen & Swamidass, 2004; Roijakkers et al. 2005; Hagedoorn et al. 2005; Han, 2004; Powell, 1996) but only few studies (McCutchen & Swamidass, 2004; Baum, Calabrese & Silverman, 2000) to date have examined the alliances between small biotechnology firms. According to Baum, Calabrese and Silverman (2000) alliances between biotech firms can also provide many of the same benefits as alliances with upstream partners (universities, research institutes and government labs). These alliances provide interaction opportunities that generate new concepts and ideas. Nooteboom (2005, 2000) defines the alliance between biotechnology firms and (public) research institutes as networks of exploration. Alliances between biotech firms could provide the same exploration benefits. As little empirical evidence is available about cooperation between small firms in the biotech industry, this study attempts to fill this gap, by examining R&D alliances established between small biotech firms. Moreover, we study the effect of these linkages on their innovative performance.

The paper is structured as follows. In the next paragraphs a literature review is presented and hypotheses are formulated. This is followed by a description of the research methods and procedures used in the study. The results are then discussed. Finally, implications, limitations, and directions for future research are offered.

2. Theoretical development

Academic publications studying cooperation between biotech firms have used different theoretical perspectives. The traditional theoretical answer to the explanation of cooperation motives has been transaction cost theory (Eisenhardt & Schoonhoven, 1996). However, this perspective does not capture many of the strategic advantages of alliances such as learning (Powell, 1996) and the creation of legitimacy (Baum and Oliver, 1991). Other theories used to explain cooperation between these firms are the resource-based and network theory. Within resource-based theory, firms are seen as bundles of resources. These resources can be tangible or intangible (Eisenhardt & Schoonhoven, 1996). Cooperation is described as an option to get access to scarce or complementary resources (Baum, Calabrese & Silverman, 2000; Roijakkers et al., 2005, Powell, 1998). In network theory, a basic assumption is that economic exchange is embedded in a particular structure (Powell, 1990). Being embedded in a network can bring numerous advantages for firms. The companies get access to enhanced resources, the risk can be shared and costs can be reduced (Rothwell, 1991). According to Larson (1992) a network is a flexible alternative to integration. We will be using both these theoretical foundations to construct our propositions on R&D alliances established between small biotech firms.

2.1 Resource based view

According to the resource based view, firms can be seen as bundles of resources; different firms possess different bundles of these resources. If firms are doing well in an industry, this can be explained by their internal resources and accumulated capabilities (Barney, 1991). If firms want to fully exploit their stock of resources and if they want to develop a competitive advantage, it could be necessary to acquire complementary resources externally (Grant, 1991). This is especially the case in high-tech industries where the sources of knowledge are widely dispersed like the biotech industry (Powell, 1998). In recent years, we witnessed an enormous growth of strategic alliances and other forms of collaboration within

The effect of alliances on the performance of collaborations in the biotechnology industry is already been studied (e.g. Deeds & Hill, 1996; Liebeskind, Oliver, Zucker & Brewer, 1996; George et al, 2001).

By engaging in R&D alliances, high technology firms get access to different resources like new knowledge (Powell, Koput, & Smith-Doerr, 1996). This enhances innovation and product development (Deeds & Hill, 1996). By forming an alliance with universities or public research centres, biotech firms get access to up-to-date information (Liebeskind et al., 1996). According to Baum, Calabrese and Silverman, (2000), alliances between biotechnology firms bring the same advantages as alliances between biotech firms and universities and research institutes. One might conclude that firms that do not cooperate or cooperate less with other companies, will be less innovative. This formulation leads to the following proposition:

**Proposition 1**: The more a small- and medium sized biotechnology firm is engaged in R&D alliances with other Biotech SMEs, the greater the subsequent innovation output of the firm.

Eisenhardt and Schoonhoven (1996) mention that in order to get resources, firms must have resources. Resources can be divided into four categories: financial capital, physical capital, human capital, and organizational capital. Small firms (less than 500 employees) have less resources and therefore are less likely to engage in R&D collaborations. Hence,

**Proposition 2**: The smaller the biotech firm, the less R&D collaborations with other biotech SMEs it will have.

### 2.2 Network theory

In the biotechnology industry the knowledge base is complex and expanding and the sources of expertise are widely dispersed. Few innovations can be assigned to a specific firm (Powell, 1998; Powell et al., 1996), as innovation requires the convergence of many sources of knowledge and skills, usually linked in the form of a network (Salman & Saives, 2005). Several studies have indicated that the positions of firms in interorganizational networks influence firm behaviour and outcomes (Powell et al., 1996; Walker et al., 1997). In order to describe the position of a firm in a network, we will be using ’centrality’. Network centrality is a measure to indicate which organizations are the key in the flow of information and exchange of knowledge within the network (Salman & Saives, 2005). According to Powell et al, centrally located firms have access to a greater variety of activities and are better able to locate themselves in information rich positions. Centrality increases the volume of patenting, non operating income, and sales. More central located actors will have sooner access to new important developments and will receive new information earlier. Hence,

**Proposition 3**: The more central the biotech SME is located within the network, the more innovative the firm will be.

March (1991) makes the distinction between two kinds of networks, namely networks of exploration and networks of exploitation. Exploration is characterized by radical innovations. It changes fundamental architectures, logics or principles of the technology. According to
Koza and Lewin (1998), networks of exploration aim at experimenting with novel combinations. New technologies are the key outcome (Gilsing & Nooteboom, 2005). Exploitation entails improvements, incremental innovations (March, 1991). Networks of exploitation aim at maximizing the joint complementary assets. The key outcomes of these kinds of networks are new products and services (Gilsing & Nooteboom, 2005). According to Nooteboom (2000), firms should be engaged in networks of exploration and networks of exploitation, but they can emphasize one of the two.

Gilsing and Nooteboom (2005) define the network between biotech firms and (public) research institutes in the biotechnology industry, as networks of exploration. The network between biotechnology firms and large pharmaceutical and chemical firms is defined as a network of exploitation.

Alliances between biotechnology firms bring the same advantages as alliances between biotech firms and universities and research institutes (Baum, Calabrese & Silverman, 2000). The network between biotechnology firms can therefore also be seen as a network of exploration. Exploration is characterized by radical innovations, therefore we offer the following proposition:

Proposition 4: The more central a firm is positioned in a network of biotech SMEs, the more radical innovations it subsequently will have.

3. Methodology

Data

Our paper focuses on the international high-tech pharmaceutical biotechnology industry. R&D partnerships are a crucial form of inter-firm collaborations in this sector (Hagedoorn and Roijakkers, 2002; Powell, Kogut & Smith-Doerr, 1996).

In order to test our propositions, we are constructing a dataset. We used the MERIT-CATI database (Hagedoorn, 1996) to select companies that formed inter-firm R&D collaborations during the period 1990-2000 in the pharmaceutical biotechnology industry. We are linking innovation measures to the firms of these R&D alliances.

Independent variables

According to Trajtenberg (1990), patent counts weighted by citations are good indicators of the value of innovations. Therefore we will be using patent citations as a measure for innovation output.
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THE UNIVERSITY SPIN-OUT PROCESS: CAREER TRANSFORMATION THROUGH THE PRACTICE OF ENTREPRENEURIAL IDENTITY

Dr Lorraine Warren
School of Management
University of Southampton
Highfield campus
Southampton
SO17 1BJ
UK

Tel: 44 (0) 2380 598972
Email: l.warren@soton.ac.uk

Abstract

The purpose of this paper is to examine in depth the nature and extent of identity work carried out by a PhD engineer involved in various phases of high tech university spin-out (USO) activity. The paper commences with a discussion, where firstly, it is established that the creation of a USO presents challenges to career development for engineering researchers which can hinder the spin-out process if not managed effectively. Secondly, it is argued that the purposeful construction of entrepreneurial identity may support successful career transformation and may therefore be a significant element in successful spin-out activity for engineering researchers. This paper goes on to examine these issues through a qualitative study of the identity and career issues in this case study. The maintenance of engineering identity is found to be most significant issue, though over time this becomes enriched through positive association with entrepreneurial growth. Recognising this career trajectory is useful to theorists of entrepreneurial identity and those involved in the practical support of USOs.
THE UNIVERSITY SPIN-OUT PROCESS: CAREER TRANSFORMATION THROUGH THE PRACTICE OF ENTREPRENEURIAL IDENTITY

Abstract

The purpose of this paper is to examine in depth the nature and extent of identity work carried out by a PhD engineer involved in various phases of high tech university spin-out (USO) activity. The paper commences with a discussion, where firstly, it is established that the creation of a USO presents challenges to career development for engineering researchers which can hinder the spin-out process if not managed effectively. Secondly, it is argued that the purposeful construction of entrepreneurial identity may support successful career transformation and may therefore be a significant element in successful spin-out activity for engineering researchers. This paper goes on to examine these issues through a qualitative study of the identity and career issues in this case study. The maintenance of engineering identity is found to be most significant issue, though over time this becomes enriched through positive association with entrepreneurial growth. Recognising this career trajectory is useful to theorists of entrepreneurial identity and those involved in the practical support of USOs.
THE UNIVERSITY SPIN-OUT PROCESS: CAREER TRANSFORMATION THROUGH THE PRACTICE OF ENTREPRENEURIAL IDENTITY

1. Introduction

The purpose of this paper is to explore the creation and maintenance of entrepreneurial identity during involvement in high tech university spin-out (USO) company processes and activities in the UK. The paper is based on a case study of a mature PhD student working initially in a research team, and later in a spin-out company, in a UK university; towards the end of the study he seeks to found his own company, moving on from the initial spin-out, though remaining in a closely related field, and continuing his role in technological development. The study tracks his understanding and development of different aspects of his professional identity as he works towards shifting career goals in different formal and informal learning settings. The paper commences with a discussion of the career tensions that might arise during the spin-out process. The next section argues that purposeful construction of entrepreneurial identity may be a significant element in supporting successful career transformation from researcher to high-tech entrepreneur. The third section presents the case in detail. Following a discussion, conclusions are presented. The practical implications of the study are that better understanding of these processes can be used by educators and support staff in classroom settings and in high-tech incubators. Theoretically, the paper adds specifically to the growing literature on entrepreneurial identity, extending it to the realm of science and engineering; more generally it adds to the literature on the decision of engineers or scientists to start firms.

The literature on why anyone starts a business is vast, covering issues at the macro level, such as policy, governance and the environment, as well as at the micro level, where the research approaches have spanned the disciplines of economics, psychology and sociology. This is too broad to review here in any meaningful way. It is noticeable however, as Audretsch and Erdem (2004) note, that there is little on why specifically engineers or scientists, as distinct from other entrepreneurs, choose to become entrepreneurial (or not), though Casson (1995) notes that technological advance presents a more intense demand for associated entrepreneurship, which may be regarded as a general attractor. Some work has been carried out in France by Fayolle (1994), who suggests that the best qualified engineers are less likely to become entrepreneurs. Chell and Allman (2003) have examined the motivations and intentions of technology oriented entrepreneurs in structured learning settings, indicating the importance of the individual, their cognitive, behavioural and emotional dimensions in interplays with the broader contextual milieu. They suggest that entrepreneurial metamorphosis is complex and difficult to predict for any individual case. Luthje and Franke (2003) also note the relation between personality, attitude and barriers and support factors on the entrepreneurship-related context for engineering students at MIT. Meyer (2003) too, examines the relation of the individual to the wider context; he concludes that public support mechanisms and incentive structures may not necessarily promote academic entrepreneurship, but develop an entrepreneurial behaviour pattern where scientists in public sector organisations are not necessarily interested in setting up a high growth company but are instead looking for an alternative avenue to pursue research interests. Anderson and Chorev (2006) explore how engineers learn to become entrepreneurs in the specific cultural context of Israel, noting that the uniqueness of the context has an impact on lifelong learning for their sample.
In summary, the relation between entrepreneurial propensity in a context of entrepreneurial support and education, and the broader societal and cultural milieu is complex and not well understood. To date, a significant missing dimension is that the dynamic between professional, academic and entrepreneurial identity for engineers and scientists has not been explored in depth; the entrepreneur is at the discussion table, the engineer is absent. Yet, as argued below, the significance of personal career choice and identity issues at key stages in the process of establishing a USO may be very significant and merits further attention.

To set the next two sections in context, a brief overview of the case history is now presented. The engineer in question, John, was born in Germany in 1970. In 1991, after school, and military service, he studied mechanical engineering to first degree level, followed by a PhD in a UK university between 1997 and 2001, on automotive electrical systems. In late 2000, as his PhD was coming close to completion he began work for a new spin-out company at the university as an R&D Engineer and Software Developer. His duties were the design of mechanical and electrical hardware as well as software for precision measurement systems. From September 2004 – 5, John also undertook a Masters course in entrepreneurship with a strong focus on business venturing. He is now in the process of setting up his own company in a closely related field and in late 2005, has attracted first round funding from a range of investors.

2. Creating a USO: Challenges to career development

There is considerable interest in the UK in the creation of wealth from the commercialisation of university research. USOs are new firms created specifically to exploit commercially knowledge, technology or research results developed within a university. The spinning-out of new technologies through the formation of new companies is one mechanism by which commercialisation might occur, though the UK is as yet underdeveloped in this area (Bray and Lee, 2000; Nicolaou and Birley, 2003a,b; Vohora et al, 2004). Although creating a spin out presents significant challenges to academics, as it involves a transition from a non-commercial to a commercial environment, nonetheless, a spin-out is attractive as it can potentially provide higher revenues to universities and to the founding academics (Bray and Lee, 2000). However as Meyer (2003) notes, a spin-out may also function simply as a grant-generator for furthering research, rather than target high growth (intentionally, or unintentionally).

The structure, form objectives and outcomes of USOs vary significantly according to a number of factors including the status of the individuals carrying out the business venturing process and the nature of the knowledge or technology being transferred (Pirnay et al, 2003). Nicolaou and Birley (2003a) argue the process of spin-out emergence is contingent in part on the role and degree of involvement of key academic staff. They propose a trichotomous categorisation of USOs into orthodox, hybrid and technology spin-out. An orthodox USO involves both the academic inventors and the technology spinning out from the institution; the hybrid situation refers to the technology spinning out and the academics retaining their university position, but holding a part-time position within the company, such as a directorship; a technology spin-out involves the technology spinning out, but the academic maintaining no substantive connection with the newly established firm (beyond, perhaps, an equity position, or the provision of consultancy advice). Nicolaou and Birley (2003b, p.1704) note that the trichotomy implies that, at the individual level of analysis, every academic inventor is faced with a critical career choice. On the one hand, the inventor may leave the university to completely focus his or her energy in the firm (academic exodus). On
the other hand, the inventor may decide to remain in the university and may or may not accept a part-time position in the firm (academic stasis). Of course, the career choices for those in temporary positions in research units, PhD students such as John for example, the career choices may well be a little less clear cut. In this case, the choice is between developing the USO, developing a new company in a related field, obtaining temporary research funding to continue ‘pure’ research, obtaining work elsewhere in the university, or leaving the university: not between a ‘secure’ academic position and the USO possibility. Whatever the starting position of the individual in question, PhD student or a fully-tenured academic, if the choice is to follow the USO route, this presents a set of personal and organisational challenges and tensions to the potential entrepreneur. Overcoming these challenges is vital if new high tech firms formed are to prosper.

Vohora et al (2004) identify 5 phases of growth for high-tech USOs: the initial research phase, the opportunity phase, the pre-organisation phase, the re-configuration phase and the sustainable high growth phase. In order to reach full potential, the venture must successfully make the transition between the phases, overcoming what are termed ‘critical junctures’ as they move from one phase to the next. The critical junctures concern the absence of key resources or capabilities required by the firm, some of which are tangible business necessities, such as finance, others are less tangible, associated with the personal motivation and career intent of the potential academic entrepreneur. It is these less tangible capabilities associated with the entrepreneur that are the concern of this paper, as they include the decision as to what career path to follow. These appear to be most significant in the juncture between the opportunity recognition phase and the pre-organisation phase, and the juncture between the pre-organisation phase and the re-configuration phase.

Turning to the first phase transition, ‘entrepreneurial commitment’ is the juncture that is most significant in the move from opportunity recognition – the idea that a new technology may have commercial potential – to the pre-organisation phase. It is in the pre-organisation phase that many fundamental uncertainties about industry, location, size, market, and team issues are resolved. Strong intention and commitment are necessary to move forward from a vision to an operational business engaged in commercial transactions (Erikson, 2002). It is here that the decision for academic exodus or stasis takes place. Vohora et al identify possible challenges to entrepreneurial commitment at this critical juncture:

1. institutional culture prioritising research
2. the challenges of an alien commercial environment
3. founding a USO is risky, engineers/scientists may be risk averse
4. difficulties in delegating to business specialists.

At this point, the academic may decide on stasis, or exodus; exodus may still take place, but the academic may remain in a research role, relying on other team members to carry out business functions. Vohora et al (2004) use the term ‘surrogate entrepreneur’ for this possibility.

Turning to the second phase transition, once commitment has been achieved, then there is the issue of credibility, the juncture between the pre-organisation phase and the reconfiguration phase. This is the ‘building’ phase for the organisation, the choice for growth, or existence; a choice for growth is dependent on presenting a credible business-like front to customers and financiers. To some extent, going for growth is a functional business issue that can readily be addressed through support in the development of feasible business models, plans and
effective presentations, but legitimacy and trust issues also impact at the personal level (Lounsbury and Glynn, 2001) in dealing with sceptical customers and investors. As Meyer (2003) points out though, some firms remain in incubators for years, subsisting on public grants and infusions of ‘love money’ from the founders themselves.

Vohora et al (2004) present evidence that it is the pre-organisation phase that represents the steepest learning curve for the academic; particularly if they have little or no commercial experience or knowledge of how the industry operates. The entrepreneurial learning has to take place in the context of contemplating a significant career shift that carries with it considerable career risk in terms of university cultures that prioritise research output rather than commercial activity, as well as business risk. They also argue that it is the re-configuration phase that presents the steepest learning curve for the entrepreneurial team, where the academic has to manage a new team role, whether as an entrepreneurial leader or not. Of course, this latter depends on the goals of the reconfiguration phase.

Mainstream tenured academic staff who choose a high degree of involvement in a USO are inevitably moving away from a linear model of classical academic career development to a less traditional, multi-faceted path where entrepreneurship is more central, at least for a time. Not only is this challenging, but work is not just about financial reward; it is a source of personal identity and self-fulfilment (Baruch, 2004). Politis too (2005), argues that entrepreneurs have diverse career motivations and that self-image is an important element in the conceptualising of decisions and motivations surrounding career choice. Baruch (2004) notes that career success is different for various constituencies:

- **internal**, how a person sees the development of own career in terms of inner values, goals, aspirations
- **external**, how career success is perceived by the external environment, in terms of status, hierarchy, income and power
- **organisational**, in terms of organisational power and influence

While Baruch (2004) notes that the academic career has a certain fluidity of its own, nonetheless, the academic entrepreneur has to carefully balance their USO aspiration -- stasis or exodus -- against organisational and external perceptions as well as internal goals. It could also be argued that self-image too has an external dimension in terms of the identified need to appear credible and business-like to potential investors and customers: should this be delegated to other team members, the inventor academic remaining in the ‘back room’?

From John’s point of view, his career development is steeped in the culture of academe and engineering. Considering moving to an entrepreneurial career position would require a reworking of internal values and beliefs to meet his own aspirations and institutionalised sets of expectations of the university and the commercial world. Yet John is a PhD student, not a tenured academic, which will inevitably set his career decisions in a different context. In this paper, I contend that crafting an entrepreneurial identity may be part of effecting a successful career transformation – but what does that mean for a PhD engineer? The next section underpins this argument.

**3. Formulating an entrepreneurial identity**

In this section, I address Down and Reveley’s (2004, p. 236) “the social formation of the entrepreneurial self”, from the point of view of career transformation. Some authors have
argued for an empowered vision of entrepreneurial identity (Lounsbury and Glynn, 2001; Down and Reveley, 2004; Reveley, Down and Taylor, 2004; Downing, 2005; Warren and Anderson, 2005). In this school of thought, entrepreneurs are acknowledged as skilled cultural operators manipulating perceptions of the entrepreneurial self to achieve desired outcomes for their new ventures. For example, Lounsbury and Glynn note (2001: 554) that a key challenge for entrepreneurs is ‘to establish a unique identity that is neither ambiguous nor unfamiliar, but legitimate’, arguing for the importance of formulating an entrepreneurial identity for self and firm in acquiring legitimacy in the early stages of venturing.

This empowered understanding of entrepreneurial identity is still contested, not least because identity itself is a concept subject to ongoing debate in the academic literature (Jenkins, 1996). However, debates in philosophy (Foucault, 1982; Taylor, 1989; Dennett, 1993), sociology (Giddens, 1991; Jenkins, 1996), and social psychology (Lewis, 2003; Harré and Gillett, 1993), have resulted in a consensus that identity is not located in the personality of the individual, but instead is constituted through interaction between the individual, society and culture. Significant in this view is the notion of identity as a process of becoming (Giddens, 1991), where there is the possibility of agency, and individual identity can be negotiated through and within the sense-making systems of the surrounding cultural milieu (Jenkins, 1996). From this perspective, it can be argued that identity is related to social and cultural forms, but is not predetermined by them (Goffman, 1959; Holland et al., 1998; Lash, 1999; Creed et al., 2002). Thus, self-identity can be crafted and re-crafted as an ongoing project of the self (Giddens, 1991). This clearly has resonance with Baruch’s (2004) metaphorical conceptualisation of ‘career’ as a ‘life journey’: the emergence of the short-term portfolio career over the past two decades has placed the emphasis far more on the individual in terms of maintaining expertise and employability. In the past, the emphasis was more on the linear progression through an organisation, which in a sense ‘owned’ the career trajectory. Of course Baruch (2004) also notes that individual career progressions do not take place in isolation; they are shaped by organisational structures, cultures and processes. Thus, an individual crafts and recrafts their career as a significant dimension of self-identity, in line with Giddens’ theories of structure and agency (1991).

Goffman (1959) too argues the relation between the individual identity and the collective of the social milieu, placing an emphasis on roles in shaping identity. He describes how individuals ‘work’ their roles in relation to social expectations; here, identities and meanings are fluid, that is, negotiated and sustained in shifting role-based interactions with others. For Goffman there is a performative dimension to role maintenance where micro-level proceedings may formulate actions and situations, not just inhabit them. Goffman also argues however, that roles become institutionalized sets of social expectations, with stereotypes emerging as a more fixed form of meaning and stability. One might consider ‘academic’, ‘engineer’ and ‘entrepreneur’ as career ‘roles’ that have associated professional expectations; those aspiring to such career roles have to craft their identity to social and professional expectations.

John clearly makes a personal journey from focussing on engineering technologies in an academic setting, to becoming an entrepreneur in the high tech development milieu. I now turn to the case study to explore this in an empirical setting, to examine to what extent he carries out identity work to smooth his career transformation.

3. Becoming an entrepreneur?
   3a. Methodology
The research phase of this project was designed in an inductive and exploratory manner to obtain a rich understanding of how John recognised, considered and assessed issues of identity during his career generally, but more specifically, during his engagement with USO activity (Eisenhardt, 1989). John was chosen from the student group undertaking the Masters course because of his strong engineering background and because he was engaged with USO activity, that is, in the space where the USO evolves from research activities to a commercial organisation (Van de Ven, 1992). Additionally, the course enabled extensive space for developmental discussions between academic staff and students. This closeness enabled a speedy rapport between myself and John, especially as I too have a scientific background and have worked with engineers and USOs in a similar field at another university. The disadvantage of this closeness, is of course, bias in the data collection and the analysis which impacts on the generalisability of the study. Hence as well as material gained from one-to-one discussions between John and I, the study was augmented by consideration of reflective material prepared for other members of the academic staff during the course, and material from the company website.

Data was collected over a one-year period from September 2004-5, during the time when John was undertaking his Masters course in entrepreneurship. During that time, he moved from his initial position with an existing USO to establishing a new company in a related field. A 90-minute semi-structured interview was carried out in March 2005, during which extensive notes were taken; other sources used were, with his permission, John’s assignments for the course (in which self-reflection was a significant component), notes taken from meetings between John, his project mentor, another member of the academic staff, and myself, comments from emails and informal chats. The analysis employed the method of reflecting on the data as it emerged during the study period, to look for patterns and themes concerning issues of identity, which were then related to an explanatory framework to support conclusions. Necessarily, there is the potential for subjective bias in the interpretative phase here, in John’s interpretations and my own. Nonetheless, there is a trade-off in the depth and richness of the material obtained.

### 3b. Analysis and discussion

The analysis is divided into two parts. Firstly, John’s phases of engagement with USO activity are defined in terms of Vohora et al’s (2004) model; secondly his perceptions of career issues are analysed in accordance with that categorisation. His engagement spans 4 of the phases identified by Vohora et al (2004) and concerns two companies, A-tech (the initial USO firm he joined towards the end of his PhD) and B-tech (the firm he was in the process of starting up during this study; he would continue his role as a researcher into product development, but in a closely related field). This transition is set out on Table 1 below:

<table>
<thead>
<tr>
<th>#</th>
<th>Phase</th>
<th>Date</th>
<th>Company</th>
<th>John’s activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Opportunity</td>
<td>Pre 2001</td>
<td>A-tech</td>
<td>Academic researcher/PhD student</td>
</tr>
<tr>
<td>A-2</td>
<td>Pre-organisation</td>
<td>2001-3</td>
<td>A-tech</td>
<td>Academic researcher -&gt; company R&amp;D software</td>
</tr>
<tr>
<td>A-3</td>
<td>Re-configuration</td>
<td>2004-5</td>
<td>A-tech</td>
<td>Company R&amp;D/entrepreneurship student</td>
</tr>
<tr>
<td>B-1</td>
<td>Opportunity</td>
<td>Late 2005</td>
<td>B-tech</td>
<td>Founder</td>
</tr>
</tbody>
</table>

*Table 1 Phases of John’s engagement with USO activity*
In A-1, he is undertaking a PhD in traditional academic mode, but in a research group where a senior professor (his supervisor) is forming a spin-out which presents potential possibilities for his own career future. He also undertakes a ‘Economics for Engineers’ distance learning course, with a view to gaining business skills for the future (not necessarily the spin-out company), but leaves because it is too theoretical. In A-2, he completes his PhD and joins the company as it forms in 2001, very much in ‘engineer/researcher’ mode. In A-3, he is fully engaged with A-Tech, but still as an employee, not a shareholder. The company is successful, but not growing very quickly. He again seeks to improve his understanding of the commercial aspects of the business outside engineering by joining a Masters course in entrepreneurship with a strong practical focus on new ventures. In B-1, he is now in the process of founding his own company to seek high growth and market share, from a position where he now has equity in the firm, but remains the main product developer.

During these phases, John is working towards different career goals in formal and informal settings. I now analyse his perceptions of self and career during these phases drawing largely an interview which covered the history of each phase. It is particularly important to note, that throughout all the phases, John sees himself first and foremost as an engineer, and that in any team or business development, he would build to bolster any perceived weaknesses, but most firmly:

“I would never compromise my reputation as an engineer”

This theme recurred constantly. When asked what he considered to be the prestige factors for an engineer the following were suggested:

- Good engineers can not only make something work, but understand why
- Uniqueness of ideas
- Elegance of ideas
- For an academic engineer, publications

Noticeably here, John privileges engineering over academe. ‘Publish or perish’ haunts academe, but even for an engineer working in a university, high skill levels related to engineering are the most significant prestige factor for John.

A-1: joining A-Tech

I asked John why he had joined a spin-out, as distinct from a large company environment at the end of his PhD:

“It’s not just a way of earning money; I had a job offer from [a large car company] while I was doing my PhD, but it wasn’t what I wanted. The company [USO] was the best technology available in the jobs I was offered; in any case, a spin-out company is prestigious – if it works!!”

Here John clearly privileges the engineering reputation over money. For a mainstream academic, publication and tenure are at the heart of the career decision for exodus or stasis. For a newly qualified PhD engineer, the concerns are to be associated with leading edge technology and a USO such as A-Tech is a highly legitimate domain to work in, in terms of supporting a future career; again, a different set of priorities to the career academic. Of
course the decision was also pragmatic in that the opportunity was there, and John did not want to work for a large company in any case.

**A-2: Working for A-Tech**

John enjoys working for A-Tech as an engineer, and at the outset holds a view that if a product is good enough it will sell. During A-2 however, there is an increasing realisation, and one that he hold more strongly on reflection, that this was a little naïve. During this period, the company acquired UK government funding in the form of SMART awards to bring the technology to market. Although John was still very technology focussed, as he became more involved with the SMART work, he began to realise that the company’s marketing strategy was weak and reactive. Operational business activities were undertaken by the company’s founder, but John saw these activities as just having “nuisance value” rather than any strategic dimension. At this time, although he was meeting sales people, he maintained what he referred to as “a healthy amount of prejudice” against sales people, who were not valued, he explained, in engineering cultures if they had little or poor understandings of the product. He makes a clear distinction between ‘business’ and the potential for growth through strategic marketing. It could be argued that this is the trigger point for John to consider crafting not just a sense of self defined through technological expertise, but also through the attractions of turning technology into market growth: a market pull, not just a technological push. In other words, the beginnings of crafting an entrepreneurial identity.

**A-3 Developing through A-Tech and education**

John still enjoys working for A-Tech but is frustrated at the slow pace of growth and the lack of a strategic marketing strategy (perhaps A-tech is unable to progress through the next ‘critical juncture’ to achieve the next phase of growth). In addition he is still receiving a wage and does not have the prospect of equity, although he is working long hours and demonstrating enormous commitment. He realises the importance of business knowledge but during this Masters education phase (as well as the concomitant business development activity) he also now realises this knowledge is not just about business functions but is on a higher level – it is about engaging with different vocabularies and audiences and about the appropriate presentation of self in new settings. At this point, I asked him if it was about networking. He explained that his early experiences of networking were poor “not a valuable use of time, meeting people selling me low-level services such as business cards”. By September 2005 however, John had moved on from hovering at the edges of generic business networking events to building his image by giving a presentation at the Institute of Directors, a prestigious grouping of senior managers in the UK. In his own analysis he had gone from meaningless networking, where he was being sold things he did not want, to establishing a meaningful network of the right high-tech focussed contacts for his intended new business. Here, John highlighted the importance of being seen, not as a student, but as a ‘product developer’ by potential customers, able to “ask the customer, what is his pain, and how can my machine fix it”. To be seen as a student, or a recent student, or even an academic, was seen as a route to not being taken seriously. While he presences himself as a top-ranking engineer, this now seems to be enriched by a growing sense of entrepreneurial self.

**B-1 Out on his own**
Now that John is in the process of setting up his own company, to pursue his expertise in a closely related field under his own control, I asked him what he thought of ‘entrepreneurs’: had he ‘become an entrepreneur? Interestingly, he was fairly neutral towards the term, as he claimed it wasn’t really used in Germany (although this is changing. However, he was developing a more positive view of the term as it was now associated with ‘growth’ as distinct from the mundanities of business life, and the downside of his perception of sales. He was now beginning to see it as an attractive term, associated with growth and success. However:

“it’s not me yet – I’m still an engineer”.

I then asked him who his role models were: “early stage developers in high tech spin outs, putting good technology ideas into practice”.

Here John seems to be in the process of developing an enriched sense of engineering selfhood, with the elegance of solutions being extended from the laboratory into the market place. This manifests in two ways:

1) He is focussed not just on recognising the value of business knowledge but also on presenting the ‘right’ identity in business settings.

2) Most importantly of all is his maintenance of self as ‘cutting edge engineer’ and that spin-out activity is a legitimate dimension of engineering activity.

3) Engineering identity is not compromised by association with growth and market share.

4. Conclusion

In this brief overview of John’s transition through different phases of spin-out-related activity that tally strongly with the norms identified by Vohora et al (2004) it is clear that John is carrying out considerable work on his identity. In line with Lounsbury and Glynn (2001), the self-hood is strongly associated with the purposeful development of legitimacy for himself and for the company, to achieve market share and growth, and that legitimacy is engineering-driven. As he makes his journey from PhD engineer in the research lab, to founder of his own company he actively crafts his career, his company and his identity in line with role expectations in his professional milieu (Goffman, 1959). To conclude, the message of this paper for theorists of entrepreneurial identity, is that this case shows a powerful sense of agency concerning the elegance of engineering and its potential for commercial solutions, not an identification with heroic entrepreneurial stereotypes in the media: this is very much an empowered version of entrepreneurial identity. Practically, the career transition for either a mainstream academic (such as the founder of A-tech, though this is not the focus of this paper) or a newly qualified PhD student is complex and challenging; but better understanding of the centrality of the engineering identity and its enrichment through entrepreneurial practice may well aid those engaged in the support of USO activity. Clearly this is just one case and more studies need to be carried out to explore these ideas in more depth.

Acknowledgement

Thanks to John (not his real name) for taking part in this study. Any errors or misinterpretations are mine entirely.
Authors such as Ritchie (1991), du Gay (1996) and Cohen and Musson (2000) suggest a less empowered view of entrepreneurial agency, here, individuals are reflexively inscribed as entrepreneurs, an identity ‘on offer’ within the discursive medium of the enterprise culture. Clearly however, entrepreneurial identity is still constituted as a relation between the individual and society in some way.

A-tech actually embraces two companies on paper
References


SUMMARY

Research proposal
This paper examines and nature of identity work carried out by an engineering researcher during the establishment of a UK university spin-out (USO) and later, forming his own company. The study tracks his understanding and development of different aspects of his professional identity as he works towards shifting career goals in different learning settings.

Problem definition
The establishment of USOs is one mechanism by which better commercialisation of research might occur. To work in the USO domain may well represent a challenging career shift for an academic scientist or engineer and little is known about this dimension of the process.

Research questions
The paper considers whether the purposeful construction of entrepreneurial identity by scientists and engineers may support successful career transformation and may therefore be a significant element in successful spin-out activity.

Theoretical framework
The paper is rooted in sociological and cultural understandings of entrepreneurship that focus on the relationship between the individual entrepreneur and the social context. The dimension of interest is entrepreneurial identity, and the extent to which entrepreneurs shape and manipulate their identity as part of business development and growth. This is rooted primarily in Giddens and Goffman.

Empirical context
The research concerns data collected over a one-year period arising from interactions with a PhD student engaged in different aspects of USO activity, while participating in a Masters course in entrepreneurship.

Research design
An exploratory qualitative case study that has strengths in the richness of the interaction with the main participant; the weakness of the case is possible bias due to the closeness of the relationship with the main participant, and generalisability.

Research phase
I have produced and published a number of theoretical and empirical papers in journals or at conferences on entrepreneurial identity; some are still in review. Some are individually authored, others are co-authored with two other colleagues. The emphasis at present is on laying theoretical foundations while using empirical material to illustrate the concepts. My express interest at present is taking this work through to the engineering and science fields.

Contribution
There is a vast literature on why people choose to start businesses. There is little however on why specifically engineers or scientists, as distinct from other entrepreneurs, choose to become entrepreneurial, although a number of authors have argued that the decision emerges from a complex interplay between personal and structural factors. This paper brings the dimension of entrepreneurial career identity to the debate and extends the entrepreneurial identity literature to scientists/engineers. The importance of maintaining engineering identity is established, though positive associations with entrepreneurial growth become more apparent over time.
AN INVESTIGATION INTO THE PARTICIPATION OF WOMEN IN INDUSTRIAL RESEARCH AND DEVELOPMENT (R&D) IN THE NORTH EAST OF ENGLAND

By: Pooran Wynarczyk and Chloe Renner
Newcastle University, UK
An Investigation into the Participation of Women in Industrial Research and Development (R&D) in the North East of England

Abstract

This paper attempts to examine the level of participation of women in industrial research and development (R&D) in the North East of England, a region with low level of R&D intensity and innovation activities when compared with more prosperous regions such as the South East. Women in R&D is, relatively, a new topic of European Commission research and policy and, as a result, data on female participation in industrial R&D at a regional level is minimal. The empirical results presented in this paper, based on a sample of 60 scientific SMEs, demonstrate that the gender gap in R&D employment, particularly at senior levels, is stark in the North East.

Keywords: R&D, SMEs, Gender, Scientific Labour Market, North East of England

Introduction

This paper builds upon a research project funded by the ‘Economic and Social Research Council (ESRC) Science in Society Programme’ entitled ‘The Impact of Gender Innovation on Regional Technology, Economy and Society’, (www.sci-soc.net). The project investigates gender disparities in scientific activities in terms of research and development, innovation, invention and exploitation of IPR amongst employees working in the Science, Engineering and Technology (SET) communities in both the public and private sectors in the North East of England. It aims to identify the mechanisms by which female employees (including from the ethnic minority communities) in SET can go on to generate or actively participate in R&D, invention, innovation and the creation of IPR. The research is further supported by Higher Education European Social Fund National Programme in order to investigate gender inequality in the scientific labour market at a national level.

The paper is primarily concerned with the level of participation (or lack) of women in industrial R&D in the North East of England. It has been argued that in the 20th century technological advance became professionalized, (Freeman 1972). For many nations and companies the reliance for invention and innovation on individuals working alone or by random chance became unacceptable and a growing and more systematic investment in factors likely to produce inventions and innovations took place. This led to growing employment of qualified personnel whose job it was to generate and develop new ideas for commercial or other advantages and expenditure on R&D as, perhaps, the key factor in the innovation process, technological capability and global competitiveness, (DTI R&D Scoreboard 2005). Since the late part of the 20th century the small and medium sized enterprise (SME) sector is increasingly viewed as a key player in the production of new ideas and innovation. Over the same
period there has also been a relatively steady increase in the number of women in work, (LFS 2005).

Drawing on these themes and empirical survey of 60 Science, Engineering and Technology (SET) SMEs operating in the North East of England, this paper attempts to investigate the level of participation of women in industrial R&D. The paper will, empirically, compare and contrast between female and male employees:
- Composition of employment in terms of full time and part time;
- Composition of R&D employment in terms of full-time and part time;
- R&D employment as a percentage of total employment – as a key indication of R&D intensity and technological capacity; and
- Ownership and management structure and capacity (both scientific and non scientific positions).

This paper presents the first ever empirical investigation of the participation of women in industrial R&D in the North East of England. It clearly demonstrates that with regards to gender, there is very little data available at a UK level and even less at a regional or company level and little has been done to address the issue of gender imbalance in R&D at a policy level in the North East of England. The empirical results presented in this paper reveal that both trends, relating to lack of R&D expenditure and the gender imbalance in industrial R&D employment, are particularly stark in the North East. In a follow up paper, based on semi structured ‘face-to-face’ interview of 34 female employees of the surveyed firms, the authors aim to identify professional and personal barriers to participation of women in industrial research in the North East of England.

The paper consists of seven sections. Section one provides a brief outline of the R&D expenditure and employment in the UK followed by a section on R&D activities in different regions of the UK. Section three provides an overview of the SME sector in the UK and in the North East with a focus on R&D activities. Section four provides a brief overview of the participation of women in the labour market in the UK and in the North East. Section 5 presents some evidence on participation of women in industrial R&D. A description of the empirical data used, methods of analysis employed and empirical findings follow this. The key findings and policy implications discussed in the final section conclude the paper.

1. Business R&D Expenditure and Employment in the UK

According the data provided by Business Monitor MA14 (2005), over the period 1996 to 2004, the expenditure on R&D performed in the UK businesses experienced a steady increase, from £9,297m in 1996 to £13,504m in 2004. In broad terms the greatest absolute sums are spent on R&D in chemicals, electrical machinery and services but the greatest growth in R&D in recent years has come from construction, transport, chemicals and service sectors, providing opportunities for new entrants to the research process. A number of other sectors such as IT hardware, software, mechanical engineering and the services have also exhibited growth over the past few years. At a more disaggregated level, the high growth sectors appear to be pharmaceuticals, shipbuilding, other transport, construction, post and telecoms and R&D services. However, the latest international comparisons of data on business R&D show the UK has much larger proportions of pharmaceuticals, aerospace, food producers and oil & gas R&D than the global average but much lower proportions of
automotive. However, UK generally lags well behind the US but roughly equal to the EU average in terms of overall R&D expenditure, (DTI R&D Scoreboard, 2005).

The type of R&D tends vary by its sectoral or organisational location with relatively little basic R&D undertaken in industry with the exception of pharmaceuticals, chemistry, aerospace and R&D services. As a result, industry tends to focus on applied (35%) and development work (58%), (MA14, 2005). These four product groups account for 45% of total current R&D expenditure by detailed product group, (Chart 1).

**Chart 1: Current Expenditure on R&D Performed in UK Businesses, Selected Product Groups, 2004**

<table>
<thead>
<tr>
<th>Product Group</th>
<th>Current Expenditure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
<tr>
<td>Basic</td>
<td>10%</td>
</tr>
<tr>
<td>Applied</td>
<td>40%</td>
</tr>
<tr>
<td>Experimental Development</td>
<td>50%</td>
</tr>
<tr>
<td>Total Basic</td>
<td>55%</td>
</tr>
<tr>
<td>Total Applied</td>
<td>45%</td>
</tr>
<tr>
<td>Total Experimental Development</td>
<td>40%</td>
</tr>
<tr>
<td>Total Development</td>
<td>55%</td>
</tr>
<tr>
<td>Pharmaceuticals, Medical Chemicals and Botanical Products</td>
<td>15%</td>
</tr>
<tr>
<td>Aerospace</td>
<td>25%</td>
</tr>
<tr>
<td>Research and Development Services</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>10%</td>
</tr>
</tbody>
</table>

Source: MA14, 2005

**Employment in R&D in the UK**

In 2004, around 163,000 people were estimated to be employed in industrial R&D in the UK of whom the majority were employed as scientists and engineers (103k), technicians, laboratory assistants and draughtsmen (25k), and administration and other staff (34k). The level of employment tends to follow the level of R&D spend by industry. The percentage distribution of R&D employment in the UK is shown in Chart 2.

**Chart 2: Industrial R&D Employment Distribution, UK, 2004**

<table>
<thead>
<tr>
<th>Employment Group</th>
<th>Employment Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientist and engineers</td>
<td>64%</td>
</tr>
<tr>
<td>Technicians, laboratory assistants and draughtsmen</td>
<td>15%</td>
</tr>
<tr>
<td>Administrative and other staff</td>
<td>21%</td>
</tr>
</tbody>
</table>

Source: MA14, 2005
More specifically, the highest number employed in R&D are found in pharmaceuticals, medical chemicals and botanical products (27K, 17%), computer and related activities (19K, 12%), machinery and equipment (16K, 10%), and aerospace (15K, 9%). The remaining product groups account for just over 50% of employment in R&D.

At a corporate level, in 2004, the highest number of R&D workers are found in businesses employing between 1000 and 4999 workers but with quite a significant number (28K) found in smaller companies (<99 workers).

2. A Regional Comparison of R&D Expenditure and Employment in the UK

A comparison of the UK regions, in terms of R&D expenditure and employment, clearly demonstrates the deficiencies in the North East region’s R&D base, compared with more prosperous regions such as the South East. In 2004, the North East accounted for only 2% of UK total expenditure in business on R&D. In contrast, some 24% of the total UK R&D expenditure was attributed to the South East region. South East and Eastern regions accounted for nearly half of the UK R&D expenditure, (Table 1).

Table 1: UK R&D Expenditure Performed by UK Government Office Regions, Percentage, 2004

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Midlands</td>
<td>7.2</td>
</tr>
<tr>
<td>Eastern</td>
<td>22</td>
</tr>
<tr>
<td>London</td>
<td>6.2</td>
</tr>
<tr>
<td>North East</td>
<td>2</td>
</tr>
<tr>
<td>North West</td>
<td>12.5</td>
</tr>
<tr>
<td>South East</td>
<td>24.2</td>
</tr>
<tr>
<td>South West</td>
<td>10.1</td>
</tr>
<tr>
<td>West Midlands</td>
<td>5.9</td>
</tr>
<tr>
<td>Yorkshire and Humber</td>
<td>2.8</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>0.9</td>
</tr>
<tr>
<td>Scotland</td>
<td>4.6</td>
</tr>
<tr>
<td>Wales</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Source MA14, 2005

In the North East, R&D expenditure also has a different pattern from that of the UK as a whole. In the North East region the R&D effort is concentrated in chemicals, around 62% compared with the UK average of 28%, mechanical engineering (7.8% vs. 8.2%), and electrical machinery (3.7% vs. 9.5%), perhaps reflecting the traditional industrial structure of the region. In the growing service sector 7.1% of total R&D spend is expended in the North East while 21.1% is devoted to R&D in this sector in the UK when taken as a whole, (MA14, 2005). (Table 2).
Table 2: Expenditure on R&D Performed in UK Businesses by Government Office Region: Selected Product Groups, 2004

<table>
<thead>
<tr>
<th></th>
<th>UK</th>
<th>North East</th>
<th>East of England</th>
<th>South East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>28.2</td>
<td>62.5</td>
<td>37.0</td>
<td>32.6</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>8.2</td>
<td>7.8</td>
<td>12.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Electrical Machinery</td>
<td>9.5</td>
<td>3.7</td>
<td>7.6</td>
<td>16.1</td>
</tr>
<tr>
<td>Services</td>
<td>21.1</td>
<td>7.1</td>
<td>25.7</td>
<td>24.7</td>
</tr>
</tbody>
</table>

Source (MA14, 2005)

In terms of R&D expenditure per head of population, compared with other UK regions, the North East had one of the lowest expenditure per head of population in 2004, with £106 per head spent on R&D compared with the national average of £226 per head of population. The largest expenditure per head was the Eastern region (£541) followed by the South East and South West regions, both with £270 per head, (Chart 3).

Chart 3: R&D Expenditure per Head of Population

Source (MA14, 2005)

In 2004, the R&D employment per head of thousand population in the North East was also significantly lower than the South East and Eastern regions, (Chart 4).

Chart 4 – Employment in R&D, by Region, 2004

Source (MA14, 2005)
3. An overview of the SME sector in the UK and the North East

There is increasing evidence that new or small firms play an important role in the production of innovation, which is not only considered crucial to the growth of output, productivity, competitive advantage, high quality employment and overall success of the economy, but also a fundamental driving force behind rising living standards, (DTI, 2003, Sheikh and Oberholzner, 2001, Lawson and Longhurst, 2006). Small Medium sized Enterprises (SMEs) represent over 90% of businesses worldwide, (WIPO, 2006). Recent research, however, clearly demonstrates that while it is evident that in aggregate terms small firms play an important role in local and national economic development, only a small proportion of enterprises from the total SME population are responsible for the majority of positive effects. Indeed, the EC's Enterprise Directorate-General (DG) has recognised that from the total population of European SMEs, only a fraction (2%) are responsible for the majority of competitive innovations and R&D and thus jobs created, (SME Update, 2006) and they are, as such, vital to regional and national economies insofar as they stimulate growth and diversity in the knowledge base. Over the past two and half decades, the UK has experienced a substantial increase in the number of enterprises, from some 2.4 million in 1979 to over 4 million in 2003, (SBS, 2004). The information provided from Europa, (2005) suggests that the percentage of organisations which are involved in innovation and R&D activities in the UK are directly correlated to the size. Independently owned SMEs only account for around 4% of the total business R&D in UK, (DTI, 2005). It has also been claimed that in the UK less than 40% of researchers in the business enterprise sector are employed in SMEs, (R&D Expenditure in Europe, 2006), (Chart 5).

Chart 5: Percentage of Expenditure on R&D Performed in the UK Business by SME, 2004

Continuing statistics also reveal that the rate of new firm formation varies between UK regions and to the disadvantage of less favoured regions such as the North East in which high business failure rates have also been observed. The economic diversification and growth in the North East is further “hampered by the lack of an entrepreneurial culture, with low levels of new business formation”, (One NorthEast, 2003: p.44). The number of businesses per 10,000 of the population also emphasises the weak nature of the North East’s business base. There were just 484 businesses per
10,000 resident adults at the start of 2003 in the North East compared to 846 in the UK as a whole and 1084 in the South East. This is over 40% fewer businesses per head of population than the UK as a whole and amounts to a ‘significant enterprise deficit’ in the North East, (SBS, 2004). The Business Monitor MA14 does not provide a regional breakdown of R&D expenditure in independently owned SMEs in the UK. However, the weaknesses of the North East in terms of these critical factors are also indications of low levels of R&D expenditure amongst SMEs and availability of a highly qualified and professional workforce and business researchers.

4. Women in the Labour Market in the UK

Evidently, over the past decade there has been a relatively steady increase in the number of women in work in the UK, (LFS 2005). However, women are still less likely to be in employment compared with men. In 2004, the employment activity rate for women stood at 70% compared with 79% for men. Women are also less likely to work as managers or senior official. In 2004, only around 11% of all women in employment held managerial positions compared with 18% of their male counterparts, (Equal Opportunities Commission, 2005). Women in the UK are particularly under-represented in senior positions in the areas of Science, Engineering and Technology (SET). Participation by women in the labour market in the North East of England has continued to remain below the national levels. In 2004, the overall female activity rate for the North East was around 68% compared with 73% at the GB level. Women in the North East are particularly under-represented in three of the highest paid occupations, namely managers and administrators, professional and associate professional and technical occupations. There are substantially fewer female managers and professionals, in proportionate terms, in the North East than nationally. In 2004, for example, only 8.9% of the female workforce were employed as managers and senior officials compared with 11% nationally, (LFS, 2005).

5. Women in Industrial R&D

It might be assumed, all other things being equal, that women would play their full role in the research work throughout the country but we know very little about their participation in industrial R&D in the UK, let alone at regional levels. In general, there is only limited data available at the firm, regional or even national level in relation to women's engagement in technological change and there are no published figures on women's employment or contribution to the various facets of industrial R&D in the UK. This appears to result largely from the issue not being addressed by national or regional policies and a general lack of research from elsewhere, notably academia. As stated in ‘Women in Industrial Research, A Wake up Call for European Industry’, ‘understanding the positions of women and men in industrial research in Europe is hampered by the lack of reliable, harmonised sex-disaggregated statistics’, (2003, p14). However, limited data clearly demonstrate the unacceptably low level of participation of women in industrial research in most Member States; ‘Europe in general has not been successful in attracting women into industrial research’. According to the first official data from ten EU Members States (excluding the UK as no data was available), presented in the above report, in 2003 women constituted less than 15% of industrial researchers in the EU. In France, in contrast to the UK, gender disaggregated data has been available since 1993 and in 1999 it was claimed that there were some 13,500 female researchers in industry representing 17.3% of all French
A relatively higher proportion of the industrial research and engineering workforce in the USA is also female (N=323,000, 19% of all researchers in industry, i.e. more than twice the total UK industrial R&D workforce). The opportunities for employment in R&D and invention and innovation are dependent on the region in which you are located and sadly these opportunities appear to be particularly low for women in regions with low R&D intensity such as the North East of England.


The focus of the empirical analysis reported below is on female employees working in SMEs engaged in Science, Engineering and Technology (SET) related sectors, operating in the North East of England. In the process of identifying these firms in the North East of England a questionnaire was sent out to over 600 SMEs operating in various SET related industrial and service sectors in the North East of England. In the process of identifying these firms various company directories and data sources were consulted, including, DTI SMART AWARD winners, FAME, AIM, Queens Award to Industry, North East Chamber of Commerce, companies located in the North East Business Incubators and business parks (e.g., North East Business and Innovation Centre/BIC). The questionnaire was specifically designed, covering several aspects of the business operations including an overview of the level and nature of innovation and R&D activities, technological characteristics, employment by gender, ownership and management structure by gender, human resources practices, skills and training policies, equal opportunity policies, flexible working practice, etc. The postal survey resulted in the creation of a unique database of over 200 SMEs. A number of experts from the North East Business and Innovation Centre were consulted to assist in the identification of SET SMEs from the database. As a result, 60 firms were identified and included in the analysis.

Furthermore, semi structured ‘face-to-face’ interviews were held with representatives of around 20 of these 60 enterprises to explore in more detail their equal opportunity policies, flexible work practices, skills and training, management structures, human resource development policies, R&D and innovation processes notably as they encourage the participation of women in R&D and other scientific activities. They were also encouraged to provide details of their key female employees involved in technical, scientific, R&D and innovation processes, as well as those involved in non-scientific activities such as sales, marketing and human resources. Around 70 member of staff were contacted and semi structured face-to-face interviews were conducted with 19 female employees engaged in industrial R&D and technological advance as well 15 female engaged in senior and managerial position but in non-scientific areas. The purpose of this exercise was to identify the level of involvement in R&D and innovation activities, background, qualification, current and previous positions, tasks undertaken possible causes of inequalities, e.g., segregation, gender stereotyping, institutionalised discrimination on recruitment, pay gap, aspiration, access to skills and training, work-life balance, family commitment and childcare, personal and professional barriers to entry and progression, etc. The results of the postal survey and face-to-face interviews have provided a wide range of both quantitative and qualitative data. However due to the limitation of space, this paper focuses on size and distribution of total employment, R&D employment, R&D employment as percentage of total employment - a key indication of R&D intensity.
and technological capacity - and management structure, between female and male employees. The results of the qualitative survey and face-to-face interviews with female employees will be presented in a follow up paper.

**Employment Characteristics**

The construction of total employment by gender is presented in Table 3. As the table clearly illustrates, around 3% of the firms had no employees and the largest surveyed firm had 87 employees. In fact over half of the surveyed firms had less than ten employees and only 3% had more than 50 employees. This is an interesting finding as previous studies on scientific/innovative SMEs in the North East had shown that these types of firms were more likely to be from the medium sized sector (i.e. those between 50 and 250 employees) than small (i.e. those between 10 to 49 employees) or micro firms (i.e., those with less than 10 employees), see for example, Wynarczyk and Thwaites, 2000.

Further examination of the table reveals some significant gender imbalances in the employment structure of the surveyed firms. For example, the table shows some 28% of the firms had no female employees compared with only 6% of the surveyed firms with no male employee. Furthermore, as demonstrated by the averages and medians, women generally tended to hold a smaller share of the workforce compared with their male counterparts. The average firm had ten male employees compared with only 4 female employees. Only 3% of the firms had more than 20 female employees but 12% had more than 20 male employees. The range of female employees was 24 compared with 70 for male employees. It is interesting to note that one of the surveyed firms had no male employees but only two female staff, one proprietor who was also behind the development of new aromatherapy products and one female director responsible for marketing and sales. In short only 25% of all jobs were held by female compared with 75% of total jobs held by male staff, (Table 3, Chart 6).

<table>
<thead>
<tr>
<th>Table 3: Employment Structure by Gender in 2003/2004</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1-9</td>
</tr>
<tr>
<td>10-19</td>
</tr>
<tr>
<td>20+</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>Sum</td>
</tr>
<tr>
<td>% of Total</td>
</tr>
</tbody>
</table>

Source: SERU SME Database
Chart 6: Percentage of Jobs Held by Men and Women 2003/2004

Percentage of Total Jobs Held by Male and Female, 2003/2004

Male - 75%
Female - 25%

Source: SERU SME Database

R&D Employment
The construction of R&D employment by gender is presented in Table 4. As the table shows, 45% of the firms had no employees specifically responsible for R&D activities. The table clearly demonstrates that women are particularly under-represented in R&D positions within this highly important segment of the region’s economy, i.e. SET related SMEs. As the table shows over 91% of the surveyed firms had no female R&D employees, over twice as many as without male employees. The remaining 9% of firms with female R&D employees recruited less than five female R&D employees. In contrast, over 10% of the firms recruited more than five male R&D employees.

Table 4 – R&D Employment by Gender

<table>
<thead>
<tr>
<th>Size</th>
<th>Total Employed %</th>
<th>Total Employed %</th>
<th>Total Employed PT %</th>
<th>Total Male %</th>
<th>Total Male FT %</th>
<th>Total Male PT %</th>
<th>Total Female %</th>
<th>Total Female FT %</th>
<th>Total Female PT %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>44</td>
<td>44</td>
<td>81</td>
<td>44</td>
<td>81</td>
<td>91</td>
<td>94</td>
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<td>1-4</td>
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<td>47</td>
<td>50</td>
<td>19</td>
<td>9</td>
<td>6</td>
<td>6</td>
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<tr>
<td>5-9</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10+</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>2.06</td>
<td>1.63</td>
<td>0.44</td>
<td>1.88</td>
<td>1.56</td>
<td>0.31</td>
<td>0.19</td>
<td>0.06</td>
<td>0.13</td>
</tr>
<tr>
<td>Median</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Range</td>
<td>12.00</td>
<td>12.00</td>
<td>3.00</td>
<td>12.00</td>
<td>12.00</td>
<td>3.00</td>
<td>3.00</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>% of Temp</td>
<td>15</td>
<td>11</td>
<td>4</td>
<td>13</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Source: SERU SME Database

Further examination of the results show that only 9% of the total R&D jobs were held by women and the remaining vast majority of 91% were held by male employees, (Chart 7).
The proportion of R&D employees as a percentage of total employment is one indication of the level of R&D effort and intensity. Technological capability and innovativeness have been linked to the percentage of qualified scientists employed in R&D related positions, (see for example. Blackburn et al 2000). The results show 15% of the total workforce was engaged in industrial R&D. However, only 1% of these were female, (Chart 8).

Management Structure
In terms of engagement in and holding specific roles at senior and managerial levels, the results show women are far more likely to hold managerial positions in the areas of HR and Marketing than R&D and other scientific and technological related posts, (Charts, 9 & 10). For example, a significantly higher proportion of female (26%) had HR managerial positions than their male (10%) counterparts. In contrast only 3% of female had R&D and other scientific positions compared with some 40% of male. In terms of Sales, Marketing, and Finance, although there appear to be a relatively higher proportion of female managers, their participation was ‘relatively’ and in relation to sales was, ‘significantly’, lower than their male counterparts.
Table 5 – Managerial Roles, by Gender

<table>
<thead>
<tr>
<th>Specific Manager for</th>
<th>All %</th>
<th>Female %</th>
<th>Male %</th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D</td>
<td>41</td>
<td>5</td>
<td>36</td>
<td>3.70**</td>
</tr>
<tr>
<td>Technical/Scientific</td>
<td>33</td>
<td>5</td>
<td>28</td>
<td>2.70**</td>
</tr>
<tr>
<td>Design</td>
<td>31</td>
<td>8</td>
<td>26</td>
<td>2.20*</td>
</tr>
<tr>
<td>Operations</td>
<td>49</td>
<td>13</td>
<td>39</td>
<td>2.52**</td>
</tr>
<tr>
<td>Production</td>
<td>52</td>
<td>17</td>
<td>41</td>
<td>2.30**</td>
</tr>
<tr>
<td>IT</td>
<td>49</td>
<td>18</td>
<td>39</td>
<td>2.06*</td>
</tr>
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<td>Data processing</td>
<td>29</td>
<td>18</td>
<td>13</td>
<td>0.62</td>
</tr>
<tr>
<td>Marketing</td>
<td>50</td>
<td>21</td>
<td>39</td>
<td>1.6</td>
</tr>
<tr>
<td>Finance</td>
<td>57</td>
<td>21</td>
<td>36</td>
<td>1.3</td>
</tr>
<tr>
<td>Purchasing</td>
<td>51</td>
<td>18</td>
<td>33</td>
<td>1.4</td>
</tr>
<tr>
<td>Exports</td>
<td>18</td>
<td>3</td>
<td>15</td>
<td>2.05*</td>
</tr>
<tr>
<td>Sales</td>
<td>44</td>
<td>13</td>
<td>36</td>
<td>2.5</td>
</tr>
<tr>
<td>Legal</td>
<td>26</td>
<td>10</td>
<td>18</td>
<td>0.9</td>
</tr>
<tr>
<td>Personnel/HR</td>
<td>36</td>
<td>26</td>
<td>10</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Paired Sample Mean T-Test differences between female and male managers
* Significant at 10 per cent level
** Significant at 5 percent
Total number of companies - 60

Source: SERU SME Database

The results generally suggest that women are not participating in the scientific managerial labour market at equal levels to their male counterparts. However, the results presented here illustrate that they are making a reasonable contribution in the managerial labour market of the scientific enterprises in terms of, for example, marketing and sales and hold a stronger position in personnel than their male counterparts. Studies of innovative and high growth SMEs have demonstrated the importance of a well structured formal management team with complementary expertise both scientific and non scientific. Scientific enterprises are generally set up by directors with scientific and technical expertise. As the company grows unless the owner’s expertise is supplemented by ‘professional’ management, performance is likely to stagnate or decline, (Wynarczyk and Thwaites, 2000). For a rapidly growing scientific small firm, the largely informal management style of the typical owner-manager will need to be supplemented by the recruitment of new managers with complementary skills, particularly in the areas of sales and marketing to develop a more formal managerial structure in order for growth to be successfully achieved, (Wynarczyk et al, 1993).
7. Concluding Remarks

This paper has examined the level of participation of women in industrial R&D in the North East of England. Although there is a lack of detailed data relating to R&D and innovation activities throughout the UK, it is relatively easier to identify regional differences than gender imbalances. North East underperforms compared to the rest of the country in terms of both expenditure and employment in industrial research and development in business and accounts for only around 2% of UK business expenditure on R&D in 2004. The exception to this appears to be the Chemicals sector where the North East performs well.

With regard to gender, there is very little data available at a UK level and even less at a regional or company level and little has been done to address the issue of gender imbalance in R&D at a policy level. Available data suggests that women make up as few as 15% of the industrial researchers in the EU according to official data from ten EU member states which, tellingly, did not include the UK due to insufficient data. France, in comparison, has been collecting disaggregated data on this topic since 1993 and in 1999 said that around 17.3% of its researchers were women. In the United States, where women represent 19% of R&D employees, the total number of women employed in industrial research is greater than that of the entire UK R&D workforce. Although the issue of women and science has featured in EU policies for some time, women in industrial research is a new topic of European Commission research. This
lack of data clearly has policy implications not only as a European level, but at a regional level too.

By extension, data on female participation in industrial R&D at a regional level is minimal. The empirical survey carried out for this paper suggests that both trends, relating to lack of R&D expenditure and the gender imbalance in R&D employment, are particularly strong in the North East. 45% of the SET firms surveyed had no employees with specific responsibility for R&D and over 91% had no female R&D employees at all. Confirming popular perceptions, women were far more likely to hold managerial positions in human resources and marketing than in R&D or science. It can be argued that as the R&D activities in the North East is low there is not demand for qualified scientists and R&D researchers. However, there is evidence that North-East manufacturers are hiring staff from Europe in a bid to tackle skills shortages as demonstrated by comments provided by one of the participating firms ‘we may force to import skilled labour from Europe if North-East skill shortages continue to hamper our global expansion plans’. It is essential to ensure that there is a sufficiently qualified workforce both in terms of number and skill level to meet these future demands by drawing on a wider pool of talent and ideas, including the participation of women who are currently so under-represented.

From the evidence provided above it appears that there is very little evidence of a gender-balanced scientific workforce in the R&D departments of North East companies. In a follow up paper, based on semi structured face-to-face interviews with 34 female employees of these firms, the authors attempt to explore some key issues surrounding the participation (or lack) in industrial R&D such as qualification, background, family commitment, as well as personal and professional barriers to entry and progression.

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PERSONAL AND PROFESSIONAL BARRIERS TO PARTICIPATION OF WOMEN IN INDUSTRIAL RESEARCH AND DEVELOPMENT (R&D) IN THE NORTH EAST OF ENGLAND

By: Pooran Wynarczyk and Chloe Renner
Newcastle University, UK

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SERU/Newcastle University, UK

Abstract
Concerns about the under-representation of women in science, engineering and technology (SET) in the UK have been raised by the Government and various other organisations since the seventies. However, ‘Women in Industrial R&D’ is relatively a new topic of policy and research. Based on ‘face-to-face’ interviews with 34 females working in some 60 scientific enterprises, this paper attempts to explore professional and personal barriers to participation of women in industrial R&D in the North East of England, a region with low levels of innovation and R&D activities. The results generally paint a more complicated picture than the traditional perception of overt discrimination against women and their career progression. Indeed institutional sexism largely appears to have been successfully tackled in many industries. More subtle issues such as male perception, rich male dominated informal networks, confidence-building, widening career horizons, and breaking down occupational stereotypes will take many years to achieve.

Key words: R&D, Gender, Scientific Labour Market, North East of England, SMEs, SET Pipeline

Introduction
Industrial research and development (R&D) critically relies on qualified researchers in the areas of science, mathematics, computing science, engineering, biology and chemistry. Despite the fact that in most European countries the numbers of female graduates are proportionately higher than those of male graduates, the scientific labour market remains male-dominated. Female graduates in the scientific disciplines generally constitute a small proportion of all female graduates. For example, in the UK, in 2002/2003 54 per cent (573,100) of all graduates were female, however, only around 15 per cent were in engineering and technology and around 18 per cent were in physical sciences, (EOC, 2005).

Concerns about the under-representation of women in Science, Engineering and Technology (SET) have been raised and expressed by the Government and various other organisations since the seventies. In 1994, the UK Committee on Women in SET produced the report ‘The Rising Tide’ - A Report on Science, Engineering and Technology, (HMSO: 1994). This report provided an overview of the continual ‘dropping out’ of girls and women at every stage of the SET ‘leaky pipeline’ - from choosing science subjects at school, to first degree, higher degree, and then in the scientific labour market. The Rising Tide identified a number of key areas of concern, including, education, training, employment and positions of influence. Since the publication of the report, considerable efforts have been devoted to the development of numerous initiatives, reports and consultation, particularly at national levels. In 2002, for example, the Government commissioned Baroness Greenfield to investigate the reasons for the low participation of women in SET. In her report, ‘SETFAIR’,
Greenfield concluded that Women are underrepresented in nearly all areas of scientific activity and the slow progress in attracting women with an appropriate level of education into a SET career is based on; continued lack of information; few visible role models and mentors; pedagogy of science and technology; and little hands on experience, (DTI, 2002).

However, even with the slight improvement in female participation in the scientific labour market in recent years, the number of women reaching high positions in science is still much lower in the UK, particularly in the less favoured regions such as the North East compared to the USA and many other European countries, (ONS, 2004). Moreover, women in industrial R&D is a relatively new topic of EU policy and research and, as such, data on female participation in industrial R&D in the UK at national or regional levels is minimal. We know that women's recorded participation in science, technology, innovation, etc. is lower than their overall participation in the workforce, particularly in the North East of England, but we do not know the details of why this is the case. As a result, the region may be missing a fundamental means of increasing its R&D base, (ONS, 2004).

This paper builds upon a research project funded by the ‘Economic and Social Research Council (ESRC) Science in Society Programme’ entitled ‘The Impact of Gender Innovation on Regional Technology, Economy and Society’, (www.sci-soc.net). The project investigates gender disparities in scientific activities in terms of research and development, innovation, invention and exploitation of IPR amongst employees working in the Science, Engineering and Technology (SET) communities in both the public and private sectors in the North East of England. It aims to identify the mechanisms by which female employees (including from the ethnic minority communities) in SET can go on to generate or actively participate in R&D, invention, innovation and the creation of IPR. The research is further supported by Higher Education European Social Fund National Programme in order to investigate gender inequality in the scientific labour market at a national level.

Based on the results of ‘face-to-face’ semi-structured interviews with 34 females working in 60 scientific small and medium sized enterprises located in the North East of England, the paper aims to investigate professional and personal barriers to participation of women in industrial R&D in the North East of England. The paper builds upon and expands from a recent paper which has empirically investigated the level of participation of women in industrial R&D in the North East of England, (see Wynarczyk and Renner, 2006) and to our knowledge the first empirical investigation of its kind in the North East of England.

The paper consists of three sections. Section one provides a brief background to the participation of women in SET in the UK and the North East. The empirical findings are presented in section two and section three concludes the paper. The nature of the R&D employment and expenditure in the UK and in the North East, participation of women in the labour market in general and in industrial R&D in particular have been presented in the original paper, (see Wynarczyk and Renner, 2006) and due to the limitation of space will not be revisited in this paper.
Section 1. Women in SET and R&D
In most European countries, the numbers of female graduates is proportionately higher than those of male graduates. However, the scientific labour market remains male-dominated. Women face obstacles to their scientific work simply because they are women, and as a result, are under-represented in the sciences and decision-making bodies concerned with scientific issues, (European Communities, 2003). According to the UK Government Initiative, ‘Promoting Science, Engineering and Technology (SET) for Women Unit’, “although women are beginning to make progress in SET, albeit slowly, they have not entered all disciplines of SET to the same extent as men. Where they have, they remain at or near the bottom rungs of the ladder. Moreover, in some fields, the position of women is worsening.” (SET4Women, 2004)

Etzkowitz et al (2000) in discussing the place of women in science and technology (this discussion is limited to the processes by which women achieve final positions as senior academics) sees the process of gender differentiation beginning at a very early age. They suggest that women have no inherent incapability to follow a career in science but that they follow a ‘pipeline’ process. The process begins in infancy with a large supply of potential scientific workers but as the process of socialising, education and employment takes place the pipeline is found to be leaking at various joints (decision points in life-chances) that results in only a trickle of women eventually emerging to make successful careers in science. Etzkowitz et al (2000) claim that from an early age:

"….boys and girls develop different gendered images of scientists and what they do." (p26).

"In many ways, women are unable to choose to do science: society has already chosen who will do science through its construction of gender roles." (p47).

The home and school environment influences girls’ vision of their role in society but also their degree of assertiveness, experimentation, self-motivated exploration and risk taking - important features in the lives of successful scientists. These factors influence women's choice of subjects at school (e.g. maths) and their subsequent capabilities and confidence to undertake front-line scientific positions. This is before taking into account family issues and explicit hostility to women in male dominated sectors. Because science has for centuries tended to be dominated by men, the culture of scientific inquiry and the cultures of scientific departments also tend to be predominantly male. Women who wish to pursue careers in science can be subject to adverse ‘weedout’, find they have to be better qualified than their male counterparts to be selected for scientific posts and have difficulty in entering rich networks of information exchange, departmental and other research teams and group grant applications. In order to succeed some women have had to adopt the characteristics of the male species. Seniority in scientific positions for the few women who fill them tends to require more items of merit and come at a greater age for women than for men. It is claimed that glass ceilings remain for women in many career paths, (Wynarczyk and Brown, 2005).

Additionally, women often feel intimidated from entering male-dominated environments such as the SET sectors and find it difficult to break out from inertia. For this reason, they often opt out of pursuing a career in such industries, with
evidence presented in Baroness Greenfield’s report ‘SET FAIR’, (DTI, 2002) showing that women with degree-level qualifications in these fields are more likely to take up clerical or administrative positions than equally qualified men. Whilst many women choose to combine a family and a career, some leave the SET community and then face additional barriers when they wish to return, to the extent that many never come back. This is a huge waste of talent, skill and investment in our society, as well as a poor example of an inclusive community.

At present, there is no gender breakdown of patents, R&D and other IPR (design, trademark and licensing), spinout and innovation activities in the UK, let alone at regional levels. The data also tends to cover women in positions that have a potential to produce technological advances, rather than identify women's contributions to various facts of R&D and engagement in the processes of invention and innovation themselves. SET data is based on skills and occupations rather than actual jobs and level of participation (or indeed the lack) in scientific activities (e.g., R&D, IPR, innovation process, etc). The opportunities for employment in R&D and invention and innovation are dependent on the region in which you are located. In spite of a long history of such activities, the North East has been consistently identified in recent years as having low levels of innovation and R&D. The region underperforms in two commonly used innovation measures - research and development (R&D) and patent activities - compared with more prosperous regions such as the South East, even when population adjustments are made, (Wynarczyk and Johnson, 2005; Wynarczyk and Renner, 2006). Sadly, these opportunities appear to be particularly low for women in the North East.

Generally, in less favoured regions of the UK such as the North East, gender inequality in the scientific labour market is partly a legacy of the tradition, culture, perception and male domination of the workforce. Women are under represented in senior positions within business, public and political spheres and earn significantly less than men, particularly in the SET sectors. As a consequence of this under-representation, there is a lack of successful female role models within the region, (Wynarczyk and Brown, 2005, RDP, 2000-2006).

Section 2. Women in Industrial Research and Development (R&D) in the North East of England: An Empirical Investigation

The focus of the empirical analysis reported below is on female employees working in SMEs engaged in Science, Engineering and Technology (SET) related sectors, operating in the North East of England. During the process of identifying these firms in the North East of England a questionnaire was sent out to over 600 SMEs operating in various SET related industrial and service sectors in the North East of England. These firms were identified through various company directories and data sources, including, DTI SMART AWARD winners, FAME, AIM, Queens Award to Industry, North East Chamber of Commerce, companies located in the North East Business Incubators and business parks (e.g., North East Business and Innovation Centre/BIC). The questionnaire was specifically designed, covering several aspects of the business operations including an overview of the level and nature of innovation and R&D activities, technological characteristics, employment by gender, ownership and management structure by gender, human resources practices, skills and training policies, equal opportunity policies, flexible working practice, etc. The postal survey
resulted in the creation of a unique database of over 200 SMEs. A number of experts from the North East Business and Innovation Centre were consulted to assist in the identification of SET SMEs from the database. As a result, 60 firms were identified and included in the analysis. Furthermore, semi structured ‘face-to-face’ interviews were held with representatives of around 20 of these 60 enterprises to explore in more detail their equal opportunity policies, flexible work practices, skills and training, management structures, human resource development policies, R&D and innovation processes notably as they encourage the participation of women in R&D and other scientific activities. They were also encouraged to provide details of their key female employees involved in technical, scientific, R&D and innovation processes, as well as those involved in non-scientific activities such as sales, marketing and human resources. Around 70 members of staff were contacted and semi-structured ‘face-to-face’ interviews were conducted with 19 female employees engaged in industrial R&D and technological advance, as well as 15 female engaged in senior and managerial position but in non-scientific areas. The purpose of this exercise was to identify the level of involvement in R&D and innovation activities, background, qualification, current and previous positions, tasks undertaken and possible causes of inequalities, e.g., segregation, gender stereotyping, institutionalised discrimination on recruitment, pay gap, aspiration, access to skills and training, work-life balance, family commitment and childcare, personal and professional barriers to entry and progression, etc. The results of the postal survey and face-to-face interviews have provided a wide range of both quantitative and qualitative data, however, for the purpose of this paper, only limited relevant data has been used.

The empirical results presented in this paper focuses on the personal and professional characteristics of 34 females, 19 with R&D related employment and the remaining 15 with non-scientific or R&D related employment. The paper compares and contrasts age, marital status, dependent children, and attempt to match their qualifications and previous positions to current positions, allowing the examination of the SET pipeline.

2.1 Women in Industrial Research in the North East: Examining the SET Pipeline

As mentioned above, current research suggests that women with degree-level qualifications in SET related fields are more likely to take up clerical, administrative or low paid technician positions than equally qualified men. However, the lack of women in industrial R&D employment within SET related SMEs in Europe as a whole has been attributed to the fact that fewer women study science related subjects at university, (European Communities, 2003) and as a result less likely to enter SET positions. Data presented in this paper attempts to match qualifications with current posts. The results of the ‘face-to-face’ interviews generally demonstrate that those women who hold scientific qualifications and are engaged in industrial R&D in the North East are more likely to hold chemical related qualifications than any other scientific qualifications and work in the chemical sector, specifically 11 out of the 18 respondents with SET related qualifications held chemical related qualifications. The chemical sector is one of the strongest sectors, in terms of R&D expenditure and employment, in the North East. In the North East, R&D effort is mainly concentrated in chemicals (62 per cent in comparison with UK of 28 per cent), (MA14, 2005). It can be argued that women have inherent skills that make them more suitable than men for different positions in the workforce. While this may be a lightly disguised excuse to discriminate against women there may be something in the argument that certain
research fields are better suited to their talents (e.g. chemicals) or for which they have a strong empathy, e.g. environmental issues. It is, therefore, interesting to note that the chemical sector is one of the few areas of scientific research in which women have the opportunity to participate in the North East. It is also interesting to note that the chemical sector in the region attracts women with chemical related qualifications from elsewhere in the country. The results show that a number of these women obtained their degrees or PhDs from non-North East universities (e.g., Cambridge, London and Melbourne, Australia) and moved to the North East to take up their current positions.

The results generally reveal that 16 out of 19 participants who held SET related position had SET related qualifications. One held non-SET related qualification and the remaining two had no formal qualifications but substantial industrial experience, which they considered as being equally important. Unlike the higher education sector, holding a scientific degree or PhD is not a requisite for having a scientific related position in the private sector or setting up a SET related company, industrial experience and inventiveness appear to be important. Further examination of data suggest that 11 out of 15 participants who held non-SET related positions had non-scientific qualifications but held, mainly, personnel, admin, business studies and marketing related qualifications. Only two of these participants held SET related qualifications but had non-SET related positions. An examination of the SET pipeline amongst the 34 participants show that 18 of all 34 participants had SET related qualifications and 16 of which held SET related positions and were engaged in industrial R&D (Diagram 1). The SET pipeline will be fully examined in a follow up paper.

Diagram 1 - The SET Pipeline (by number of respondents who held SET related qualifications)
2.2 Age of Participants
Research shows that female researchers generally tend to be younger than other employed women, (EOC, 2005, Labour Market Trends, 2003). The results presented here confirm this. A relatively higher proportion of women in industrial research were below the age of 40 (i.e., 84 per cent) than women who held non-scientific posts (74 per cent) and none were over the age of 50; (Table 1 and Chart 1)

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<th>Non-Scientific</th>
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<tr>
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<td>24</td>
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<tr>
<td>Total</td>
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<td>15</td>
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Chart 1 – Age Groups of Participants

2.3 Martial Status of Participants
Existing statistics show that married women (with or without dependent children) are more likely to work on part time basis, (EOC, 2005). In 2003, out of all married women in employment in the UK some 34 per cent worked part-time compared with 24 per cent of all economically active unmarried women, (Labour Market Trends, 2003). To our knowledge there is no data available on the marital status of the female researchers. The results of the face-to-face interviews show that 32 per cent of the women in industrial research were single compared with none of those who held non-scientific positions. The remaining 68 per cent either lived with a partner (16 per cent) or married (52 per cent) but none divorced, (Table 2, Chart 2).
Table 2 - Marital Status of Participants

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Chart 2 – Marital Status of Participants

2.4 Family Commitment

Employment rates for women are closely linked to the presence of, and ages of, dependent children in the family. In the UK, the employment rates for women with dependent children in 2004 were 52 per cent for those living with pre-school children, 71 per cent for those with primary school children and 77 per cent for women with the youngest dependent aged over 11 years, compared with 67 per cent for women without dependent children, (EOC, 2005).

In the UK as a whole, employment rates for those in a family with dependent children were much lower for single women, although lone mother employment rates have seen a rapid increase over the past five years. In 2002, the employment rates for partnered women and single women stood at 70.2 per cent and 50.3 per cent respectively. The gap between partnered mothers’ and lone mothers’ employment rates has closed by 4.3 percentage points between spring 1997 and spring 2002, (Labour Market Trends, 2003).

Existing research suggests that as women engaged in industrial research tend to be younger it may, partly, explain the reason why relatively fewer of them have children compared with other female employees. However, research also suggests that highly qualified woman are more likely to postpone maternity than other female employees, (European Communities, 2003). The results presented here show that only 26 per cent of the women in industrial research had dependent children compared with 67
per cent of the non-scientific counterparts. Around 30 per cent of participants said they did not wish to start a family, as this would prevent them from progressing further in their careers. Those who worked in chemical R&D and wished to start a family raised concerns about health and safety issues relating to handling unsafe chemicals and worried about getting pregnant in case ‘chemicals handled would harm unborn babies’. As a result, a number of women express their dissatisfaction with working in labs and preferred to find non-lab jobs even if this meant moving out of the region due to the working conditions and unattractive environment that labs generally offer, (Chart 3).

**Chart 3 - Participants with Dependents**

However, a high proportion of those with dependent children and other family commitments (e.g. living with a partner) faced problems with lack of suitable childcare facilities, barriers to participation in career development related activities such as travelling abroad and attending conferences and participation in outside normal working hours and social and networking activities, such as attending dinner parties or football matches. The following comments were quoted by a number of participants:

‘Personal circumstances at home became my main focus for a while and my work had to take a secondary role. I was not keen to pursue any further development etc as my job at that time was the most constant thing in my life’.

‘A partner did not wish for me to travel long-distance on company business, limiting my role’. ‘I have had childcare difficulties. My husband works abroad on a 4 week rota, so I have to arrange childcare for my children aged 11 and 14. This has prevented me going on business trips out of the area’.

Most of the initiatives of the Commission and the member states on women in science have focused on the public sector where statistics are more readily available - statistics on participation in the private sector, especially at regional levels, are more difficult to obtain. As ‘Women in Industrial Research: a Wake up call for European Industry’ 2003 has stated, greater participation of women in R&D within the private sector will provide access to untapped pool of talent which in return will contribute to growth and development of scientific enterprises. However, this requires a dramatic cultural and institutional change.
2.5 Other Barriers
In addition to work-life balance issues, several other personal barriers commonly shared amongst a high proportion of participants, including lack of confidence and self-esteem, lack of women scientist role models, lack of support from teachers, limited facilities at schools and low expectation of girls at school. One of the participants commented;

‘At school, I thought the height of ambition was when a girl wanted to do further training to get NNEB to become a nanny. No one talked of being a doctor – to become a nurse was an extremely high ambition’.

2.6 Professional Barriers
The results of the study demonstrate that because of EU equal opportunities legislation in education and employment formal discrimination against women have, generally, been removed. A high proportion of surveyed enterprises (around 80 per cent) had a formal or written equal opportunity policy and a high proportion (70 per cent) of women seemed to be aware of their existence. However, there are a number of both professional and institutional barriers, which continue to prevent actual equality for women in SET to take place.

In terms of professional barriers, institutional sexism, informal male networks and male biased incentives such as attending football matches or gala dinners, outside normal working hours’ social activities, male colleagues’ perceptions, as well as career development opportunities such as training have commonly been mentioned. A high proportion of women blame their male colleagues and bosses for lack of confidence or progression. A number of participants shared the following comments;

‘Sometimes I have not been taken seriously enough because I am female. For example when in the pharmaceutical profession when talking to professors/surgeons they did not expect me to have sufficient knowledge and looked down at me on occasion’.

‘There is a degree of institutional sexism, particularly with customers/suppliers of the older generation who prefer to speak to male colleagues when ‘getting down to negotiating’.

‘When I worked in London, I did not feel that there was as much a male chauvinist attitude down South as there is up North. And when I worked in Manchester there wasn’t as much ‘superior’ attitude their either’.

‘Working in a male dominated environment (90% men) it may be that my ideas have had less kudos, than those suggested by male colleagues’.

‘not being allowed to make decisions without prior discussion with a more senior male colleague slowed down the process of confidence building and inevitably affected my professional development’.

However, as the following comment demonstrates, a few participants see women minority as an advantage;

‘as there are fewer females in this area it is slightly easier to stand out. However, in saying this it is imperative that a quality job is carried out’

‘I believe the main reason I have been asked to join a high level committee is because I am a woman scientist’
One of the participants commented: ‘there are not many opportunities for alternative scientific jobs in the North East region, so I may have to move out of the region to find a more suitable job’. It can be argued that as the R&D activities in the North East is low there is not demand for qualified scientists and R&D researchers. However, there is evidence that North-East manufacturers are hiring staff from Europe in a bid to tackle skills shortages as demonstrated by comments provided by one of the participating firms commented that ‘we may force to import skilled labour from Europe if North-East skill shortages continue to hamper our global expansion plans’. It is essential to ensure that there is a sufficiently qualified workforce both in terms of number and skill level to meet these future demands by drawing on a wider pool of talent and ideas, including the participation of women who are currently so under-represented. From the evidence provided above it appears that there is very little confirmation of a gender-balanced scientific workforce in the R&D departments of North East companies, apart from chemical related businesses where there is evidence of a greater participation by women.

Section 3. Summary and concluding remarks

This paper, based on the results of ‘face-to-face’ semi-structured interviews with 34 females working in 60 scientific small and medium sized enterprises operating in the North East of England, has investigated those professional and personal barriers which tend to prevent participation and career progression of women in industrial R&D in the North East of England and make policy recommendation to remedy the current unacceptable under-representation. The paper builds upon and expands from a recent paper which has empirically investigated the level of participation of women in industrial R&D in the North East of England, (see Wynarczyk and Renner, 2006) and to our knowledge the first empirical investigation of its kind in the North East of England.

By extension, data on female participation in industrial R&D at a regional level is minimal. The empirical survey carried out in the original paper showed that that both trends, relating to R&D expenditure and the gender in R&D employment in the North East were particularly disappointing. 45 per cent of the SET firms surveyed had no employees with specific responsibility for R&D and over 91 per cent had no female R&D employees at all. It showed that, confirming popular perceptions, women were far more likely to hold managerial positions in human resources and marketing than in R&D or science and technology related positions, (Wynarczyk and Renner, 2006). The results of this paper demonstrate that women working in SET related companies are indeed less likely to have scientific qualifications, yet their qualifications are related to the positions they hold – women are more likely to have HR and marketing related qualifications than male personnel. This suggests that the frequent headlines suggesting that well qualified women are forced into administration or secretarial work, particularly in male dominated sectors such as SET, is incorrect and in fact, women do follow a clearly structured career path linked to their chosen field. Indeed, notably in the chemicals sector, women in the North East with the appropriate scientific qualifications do find themselves working in the appropriate field and in an appropriate position and there is some evidence that women have actually moved from elsewhere in the UK and abroad to the North East of England in order to work in that sector. Interestingly, a number of women working in the sector had no formal scientific qualifications, but, as with both men and women in numerous other sectors
in industry as a whole, placed a greater emphasis on their work experience. This suggests that formal qualifications, though undoubtedly important, are not the only factor in the equation.

Other factors such as age and family commitments clearly have an impact on career progression. In the survey for this paper, 32 per cent of the women in industrial research were single compared to none of those in non-scientific positions. Female researchers tended to be younger, a reflection perhaps of the well-documented SET ‘leaky’ pipeline where women progressively leak out of the SET workforce at each level, leaving an ever-narrowing pool of female employees. Likewise, only 26 per cent of women in industrial research had children compared to 67 per cent of women in non-scientific positions. Again, this may be a reflection of both the fact that female industrial researchers tended to be younger and a more general feeling that having children would be detrimental to their career in research, with some women in the survey clearly stating this was a factor in their decision not to have children. Taking into account the much-criticised, lack of basic childcare facilities in the UK, it is clear that family circumstances are a very strong factor in the career progression of women in industrial research in the UK.

Other factors include a lack of confidence and self-esteem, which may originate in perceptions formed at a young age of what constitutes ‘male and ‘female’ work. It is clear even now that these perceptions remain very strong and employers make clear reference to the fact sectors traditionally dominated by a male workforce continue to see little to no applications for vacancies from women, with strong implications for schools and career advisors.

All of these factors combine to paint a more complicated picture than the traditional perception of overt discrimination against women and female career progression. Indeed institutional sexism largely appears to have been successfully tackled in many industries, through a combination of changes in attitudes from society as a whole and through legislation. More subtle issues such as confidence-building, widening career horizons and breaking down occupational stereotypes at school level will take many years to achieve. Yet it is obvious that the barrier that most women have greatest difficulty in overcoming is reconciling the ideal of ‘having it all’ with the reality of work-life balance issues. Many of the women in this survey who enjoy a successful career in science and research freely admit that they had to make considerable sacrifices in order to achieve this. To them, it appeared that there was no obvious way to reconcile work and life and that one had to be pursued at the expense of the other. Whilst equal opportunities and work-life balance policies, childcare facilities and a flexible work schedule would all appear to offer a more attractive environment for female career progression, it would seem that these policies aid the recruitment and retention of women, mainly on part time basis, and not necessarily their career progression. In the long term, as has historically been the case, employees (male or female) with the greatest focus on their work and the least number of external commitments are the most likely to progress and succeed in that industry.

Labour Force Survey (LFS) data shows that a vast majority of managerial and senior positions in the UK are full-time. More formalised, affordable and accessible childcare facilities (e.g., full-time crèches and after school childcare facilities) are needed to encourage women to take up full-time position. It should be noted that
50:50 men to women is not equality if all senior managers are men and most junior staff are women. Women need to be more visible in senior and managerial positions. Therefore, policy is needed to encourage women to participate fully in the scientific labour market and at the highest levels in particular.

Reference

Business Monitor, MA14, (2005), Research and Development in UK Businesses 2004, Newport, National Statistics, January

DTI, (2002), Women in Science, Engineering and Technology, Report from The Baroness Greenfield CBE to the Secretary of State for Trade and Industry, November


Title:
The Klofsten Business Platform as a self-diagnostic tool for new technology-based small firms.

Authors:
John Yencken
Murray Gillin
Australian Graduate School of Entrepreneurship
Swinburne University of Technology
John Street
HAUTHORN VIC 3122

Tel: (03)9214 5870
FAX (03)9214 8381
E-mail jyencken@groupwise.swin.edu.au.
The Klofsten Business Platform as a self-diagnostic tool for new technology-based small firms.

Abstract
This paper first reviews available instruments that might be used by new technology-based small firms (NTSFs) as self-diagnostic tools to plan their future development strategies. It makes a clear distinction between tools that are for self-diagnostic internal use by such ventures and the more established tools, such as Timmons “fatal flaw analysis” and Bell-Mason, designed to assist venture capital investors in decisions whether to invest or not in a new company. The paper then analyses the application of the Klofsten Business Platform with its eight Cornerstones as a comparative diagnostic tool in over twenty case studies to the understanding of the early stages of development of new technology-based spin-off ventures from Australian and Scottish universities. The analysis is longitudinal over a period of up to six years for surviving companies. Survival rates for the sample have been compared with overall survival rates of spin-off and other new ventures in Australia.

Acknowledgements
The authors would like to acknowledge the permission from Professors Magnus Klofsten and Per Davidsson to translate and use the Swedish questionnaire originally developed by them and for ongoing help throughout this research.

Introduction
The literature on new venture creation and development describes a number of models that might be used for the assessment of new business ventures. Most of these have as their focus helping potential equity investors (friends, family and fools, business angels and venture capitalists) in their decisions whether to invest or not in that particular venture (Bell and Mason, 1991; Mainprize et al., 2003; Mason and Stark, 2002; Timmons, 1994). Klofsten (1998) has developed a Business Platform concept that was designed as a self administered diagnostic to assist small and medium sized knowledge based companies to assess for themselves their status in relation to what Klofsten identified as the Business Platform:

To survive and develop, a firm must reach a business platform early on. Therewith, the firm has achieved a condition where the initial vulnerabilities have been overcome, although this is not any guarantee that the firm will survive…A business platform is not a goal in itself, but the first very important step towards a stable growing firm (Klofsten, 1998: 13).

From this concept, Davidsson and Klofsten (2003) developed a questionnaire instrument that a firm might complete to evaluate its status in relation to this Business Platform objective. This questionnaire was evaluated by a survey of Swedish knowledge based businesses. Responses were received from 114 firms with a 36 per cent response rate. Of these firms, 58 per cent were providers of services and 35 per cent providers of products. Their average age was 6-7 years and median age 7.0 years (Davidsson and Klofsten, 2003:7). In this earlier research the focus was on helping existing knowledge based companies.

The research reported here involved case studies of newly established companies spun out by universities and other publicly funded research providers, twenty in Australia and two in Scotland. The case studies were based on well established principles (Yin, 1994; Miles and Huberman, 1994; Eisenhardt, 1989). One of the research objectives was to test the validity of The Klofsten Business Platform concept as the basis of a self-diagnostic tool and to explore its relevance for newly established New Technology-Based Firms (NTSF), not just for knowledge based companies with six or seven years’ history.
The authors finally reviewed the survival rates for spin-off companies against other new ventures in Australia and elsewhere to provide benchmarks to assess the survival rates of the case study sample.

**Reaching the Business Platform**

**The sample of companies**

The research involved case studies over the period FY1999 to 2002 of twenty two spin-off companies established in Australia and Scotland, most of which were incorporated in the period FY 1995-2000. The parent research provider organisations included both large (research expenditure greater than A$100million per annum) and small/medium research profile universities, CSIRO (the Australian national public research agency), and Cooperative Research Centres (CRCs). CRCs are an Australian Commonwealth Government initiative to bring together in the one organisational structure universities and other research providers with industry and other users of research (See www.crc.gov.au). The unit of analysis was the spin-off company. The population was theoretically sampled to ensure inclusion of a wide range of technologies and parent research providers, with wherever possible two spin-off companies from each research provider (Yencken, 2005).

The individual case studies involved both quantitative data collection using a developed survey instrument (Yencken, 2005:340) and qualitative research based on interviews with researcher inventors, managers, technology transfer staff and first investors.

**The survey instrument**

At the time when the research reported here was started, only a Swedish version of the survey instrument was available. This was translated into English in Australia by a fluent Swedish speaker. Inevitably there are small differences in translation between this earlier translation of the original Swedish instrument used here and the later translation of the survey instrument included in Davidsson and Klofsten (2003). However to avoid any incompatibilities, the same translated-in-Australia version was used both for the initial surveys in 1999-2001 and the re-interviews in 2005. The changes made to the original Swedish questionnaire included deletion of one statement that did not appear relevant in the Australian environment and expansion of the Likert response value scale from one to five to one to seven. This latter change was well validated in the responses. Respondents regularly used all scores from one to seven. The Likert seven-value opposing statements used to explore the case study company’s status in relation to the eight Cornerstones have been included as Appendix A. The complete version of the questionnaire is available in one of the present authors’ thesis (Yencken, 2005: 340). The analysis of the data in the comparative data questionnaire, based on the Davidsson/Klofsten Cornerstones and Business Platform (Davidsson and Klofsten, 2003), had a similar objective. It measured how close a business was to reaching its Business Platform.

Klofsten (1998: 7) defined the Business Platform as meaning that “the newly-started firm has achieved a state where vulnerability has decreased to the point that the firm has been able to move on to the next phase of its further development”:

The likelihood that a company would generate sustainable growth was determined by its ability to satisfy the eight pillars of Klofsten’s Business Platform (Klofsten and Davidsson, 2001) and how this ability varied over time. A key output or dependent variable in each individual case study was how it scored (on a scale 1 to 7) on each of these pillars and against some average of these scores. The eight pillars included:
The firm’s development process:

- **IDEA** The formulation and clarification of the idea behind the firm
- **PRODUCT** The development of finished products accepted by customers
- **MARKET** The definition of the market, e.g., niche large enough to be profitable
- **ORGANISATIONAL DEVELOPMENT**

**Actors close to the firm**, such as the founders, the CEO and board members:

- **CORE GROUP EXPERTISE**. Market knowledge, marketing and sales expertise, technical expertise
- **PRIME MOVER & COMMITMENT** The actors’ driving force and commitment.

**External supply of resources** in supplementary areas necessary to the firm:

- **CUSTOMER RELATIONS** These relations are important for all firms since they are the source of revenue
- **OTHER FIRM RELATIONS** A variety of different relationships; particularly important are suppliers of financial backing and supplementary knowledge

The mean scores in for the Swedish sample of 119 established knowledge based companies have been shown as Figure 1. A Likert five-value scale was used for this survey.

For the Australian sample, data on the eight Cornerstones identified by Klofsten were obtained using Likert seven-value opposed statements in the comparative data questionnaire (Appendix A). Mean values of these scores for the set of statements relating to each Cornerstone have been shown in Table 1 and Figure 2. The table has only shown scores at the time of questionnaire completion. The individual case study reports also included scores Two years ago (Yencken, 2005).

Comparison between the mean Cornerstone scores achieved by the sample of established Swedish companies (median age seven years) based on a five-value scale (Figure 1) and those for the Australian companies based on a seven-value scale (Figure 2) are very similar except for the two Cornerstones that related to established relationships. The low scores for Customer relations in the Australian data arose because many of the companies had not yet made their first sale. The low scores for Other relationships generally related to problems with finance availability. By comparison, for a well established publicly listed Australian pharmaceutical company (Company X in Table 1), the mean Cornerstone score was 6.54 (Figure 3). Only one case came close to this score, Case Number One with a mean Cornerstone score of 6.24 (Figure 4).

Interview data were collected from fifteen such companies in Australia and from two in Scotland. Three other companies were included in the qualitative research sample, Case Number Three for reference as a typical NTSF entrepreneurial start-up that had had no direct relationships with a university or other public research agency parent, and two others, Numbers Four and Eight, which turned out not be spin-off companies but rather companies that had used in one case a university and in the other a CRC as their contracted technology source. The key details of this sample of companies segmented as indicated earlier have been summarised in Table 2-4.

For the whole sample, only one company (no. 11 average score 5.39) that had an average Cornerstone score of over five failed, while there was only one company that had an average score less than 5.0 (no. 14 with average score 4.32) and was still active. However this last
company was the oldest company in the sample and it had still not at the time of interview made its first sale. The data therefore suggests that companies with an average Cornerstone score of less than 5.0 after two to three years of existence are vulnerable. Based on these data and having regard to the small sample involved, it is a reasonable but tentative conclusion that the Klofsten Business Platform approach can be used as an effective self-diagnostic tool for New Technology-based Small Firms, not just well established knowledge-based firms as originally tested by Davidsson and Klofsten (2003).

Validation of the questionnaire responses

Only one individual in each company completed the questionnaire. The interview response data were used to check and validate the relevance and accuracy of these responses. The interview transcripts showed no significant divergences from those suggested by the Business Platform questionnaire. A possible explanation for the high score for Case No. 11, which was later taken over as having a need for new management, may have been related to a change in management immediately after the interview.

Segmentation of cases

The unit of analysis has been new technology based ventures, particularly those that are spin-off companies arising from universities or other public research providers where there is an ongoing intellectual property link back to the parent research provider. Bhavé (1994: 225) drew attention to the importance of selecting samples of cases on taxonomic dimensions rather than by the usual more convenient dimensions of industry, size, technology or region. The sample here was theoretically selected on taxonomic dimensions, with NTSF class, technology and type of spin-off parent as the primary dimensions. It included seventeen cases where there were adequate qualitative interview derived data for effective triangulation. The sample included four different classes of NTSFs:

A. **Opportunity driven entrepreneurs**, the classical domain of entrepreneurship research.

B. **Direct Research Spin-off companies** where there had been an ongoing intellectual property link with and often staff transferred across from the parent research provider (Upstill and Symington, 1999; Stankiewitz, 1994; Thorburn, 1997; Hindle and Yencken, 2004).

1. **Product oriented mode (PO) companies**, organised around a well developed product (or process) concept and focussed on the advanced development, production and marketing of that product (or process).

2. **Service-oriented mode companies**, similar to product oriented mode companies but developed around a well-developed service concept.

3. **Technology asset oriented mode (TA companies)**, concerned with the development of technologies which are subsequently commercialised through spinning-out new firms, licensing, joint ventures or other types of alliance rather than by manufacturing products or delivering services

There were four classes of spin-off parent research suppliers: universities with large, universities with medium to small research profiles, Cooperative Research Centres and CSIRO as a public research agency.

The segmentation of the companies as shown in Tables 2-4, was based on Bhidé’s three types of new ventures: opportunity driven entrepreneurs, venture capital driven and corporates. The classification was based on the increased level of planning and resourcing by the parent
before the company was cut loose from this parent that was most typical for the corporates (Table 4).

**Survival of the fittest**

In this section of the paper, available data on the survival rate of spin-offs from universities and other publicly funded research agencies has reviewed to allow comparisons with the survival rates of the spin-off companies involved in the case studies reported earlier.

The Australian Bureau of Statistics has only once previously, for FY 1995/96, published data on cumulative business exit rates and survival rates (*Business Exits Australia*, ABS Cat. No. 8144.0). The 1995/96 data showed a survival rate after five years of 65 per cent both overall and for small companies and after ten years 52 per cent overall. New data (ABS Cat. No. 8160.0) were released on 23 June 2005 for FY 2000/01, 2001/02 and 2002/03. These data only included survival rates over periods of one and two years from 2001-02. Over the two year period from 2001-02 to 2003-04 the survival rate for private companies was 94.8 per cent and for public companies 72.3 per cent. By sector, survival rates for Manufacturing were 87.9 per cent and for Communication Services 82.6 per cent. Unfortunately no more up-to-date data for longer term survival rates in Australia have been produced.

**Overseas data**

The only overseas data on survival rates for academic spin-off companies has been given by Mustar (1997: 41) for France. His data showed a survival rate for such spin-offs after five years of 75 per cent by comparison with the survival rate for all new companies in France of 50 per cent over five years.

It can be seen therefore that the survival rate [after five years] is very high: continued trading for five out of every six firms and the same legal structure for three out of four firms.

He also drew attention to the importance of networking. For the group of firms that had very close links with R&D and which had entered into cooperation agreements with other French or foreign firms, ten had between 50 and 100 employees and two had staffs of 150 and 260 respectively. ‘In the group of firms without a network, half the enterprises had disappeared’ (p.41).

**Australian data**

An earlier Australian survey of university spin-offs (Yencken and Gillin, 2001:16) suggested a survival rate of 57 per cent over three to five years and 87 per cent over two to thee years (Table 5). These data on survival rates were not complete as not all companies could be contacted.

More recently for this paper the current status of all new spin-off companies established in FY 2000, as listed in the Australian National Survey of Research Commercialisation Year 2000 (ARC/NEMIC/CSIRO, 2002) was reviewed by direct contacts with the companies and/or their research provider parents. For the first time the data in this report allowed a more systematic exploration of survival rates of spin-offs that originated in universities and CSIRO, the Australian Government funded research agency. It has been possible to establish the present status of all these companies five years after their establishment. Two companies were excluded as being technology transfer vehicles rather than direct research spin-offs. The findings have been summarised in Table 6.

The survival rates for the Australian university spin-off companies established in 2000 over five years to 2005 have been 68 per cent for the university spin-offs with three (10 per cent)
under new ownership following trade sales as liquidity events. Seven companies (22 per cent) have been liquidated and three companies (10 per cent) are not actively trading. The survival rate has been lower than that suggested by the earlier survey of Australian university spin-offs shown in Table 6 for a shorter period of three years (Yencken and Gillin, 2001). All the CSIRO spin-offs established in the year 2000 were still trading with six (50 per cent) under new ownership. The survival rate for the university spin-offs is thus comparable with that for all new ventures established in 1995/96 in the ABS data (ABS Cat. No. 8144.0 Business Exits Australia), while that of the CSIRO spin-offs established in 2000 is higher.

Conclusions

Based on the data from the case studies and having regard to the small sample involved, it is a reasonable but tentative conclusion that the Klofsten Business Platform approach can be used as an effective self-diagnostic tool for New Technology-based Small Firms, not just well established knowledge-based firms as originally tested by Davidsson and Klofsten (2003).

It remains to compare the survival rates of the companies involved in the case studies reported earlier, with a reminder that this sample was theoretically sampled for a wide range of technologies and parents and is not a statistically valid random sample. The survival rates for the three groups as shown in Tables 2-4 have been:

Group A: Opportunity driven entrepreneurial ventures
Four out of seven companies (57 per cent) in this group aged 24 to 72 months had survived and were active.

Group B: Venture capital driven companies
Neither of the two companies in this group had survived but the intellectual property from one of them was still being developed after the sale of the original company. In both cases there was evidence of a lack of an effective champion. In one case the company was formed when a deal with a major pharmaceutical company fell through when it withdrew from that field of medication.

Group C: Corporate style spin-offs
Nine of the twelve companies in this group, ranging from 13 to 180 months in age, had survived and were active. One of these had been the subject a profitable liquidity event, a trade sale.

While the numbers are small, these survival rates—57 per cent for Group A and 75 per cent for Group C—support the findings from the qualitative research interviews that a higher survival rate might be expected from spin-offs that been effectively planned and well nourished with resources before being cut loose from the parent, that is the spin-offs in Group C that met Bhidé’s (2000) description of corporate style spin-off ventures. The Group C survival rate was also noticeably higher than the underlying survival rate indicated by ABS Business Exits 1995-96 data. The qualitative interview data for the two Group B companies also showed the importance of a commercially oriented champion and the likely outcomes where this does not occur.

References


ABS (1997) Cat. No. 8144.0 Business Exits Australia. Canberra: Australian Bureau of
Statistics.


Appendix A

Statements in Business Platform Questionnaire

A number of statements follow which deal with the company and its internal and external relations. These statements are placed in opposite pairs. The statements are formulated in the present, but are always concerned with two timelines: how things are right now, and how they were two years ago.

Please read the two statements. Score the company on the scale between the two according to which statement fits best. Choose 1 if the left-hand statement fits completely, or 7 if the right-hand statement fits completely. If the situation of the company was/is right in the middle, choose 4. If it doesn’t fit completely, but leans more towards one or the other statement, choose 3 or 5.

Please circle one number in each row.

<table>
<thead>
<tr>
<th>Ideas</th>
<th>Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideas and opportunities on which the company’s activities should be based are not well specified.</td>
<td>There is a clear understanding on which ideas and opportunities the company’s activities should be based.</td>
</tr>
<tr>
<td>Q.1. <strong>Now:</strong> 1 2 3 4</td>
<td>Q.2. <strong>Two years ago:</strong> 1 2 3 4</td>
</tr>
<tr>
<td>Q.3. <strong>Now:</strong> 1 2 3 4</td>
<td>Q.4. <strong>Two years ago:</strong> 1 2 3 4</td>
</tr>
<tr>
<td>There is uncertainty about which ideas and opportunities should have priority for development and investment.</td>
<td>Everybody in the company is completely clear about which ideas and have priority for development and investment</td>
</tr>
<tr>
<td>Q.5. <strong>Now:</strong> 1 2 3 4</td>
<td>Q.6. <strong>Two years ago:</strong> 1 2 3 4</td>
</tr>
<tr>
<td>It is unclear which needs of which type of customer the company’s new ventures can satisfy.</td>
<td>It is completely clear which needs of which type of customer the company’s new ventures can satisfy.</td>
</tr>
<tr>
<td>Q.7. <strong>Now:</strong> 1 2 3 4</td>
<td>Q.8. <strong>Two years ago:</strong> 1 2 3 4</td>
</tr>
<tr>
<td>It is rather difficult to say what is special and unique about the company’s development ideas.</td>
<td>It is completely clear what is special and unique about the company’s development ideas.</td>
</tr>
<tr>
<td>Q.9. <strong>Now:</strong> 1 2 3 4</td>
<td>Q.10. <strong>Two years ago:</strong> 1 2 3 4</td>
</tr>
<tr>
<td>Products</td>
<td>Products</td>
</tr>
<tr>
<td>There is no developed, market-ready product.</td>
<td>There is a well-developed product that is completely ready to sell.</td>
</tr>
<tr>
<td>Q.9. <strong>Now:</strong> 1 2 3 4</td>
<td>Q.10. <strong>Two years ago:</strong> 1 2 3 4</td>
</tr>
<tr>
<td>No user has tested the product.</td>
<td>The product has been tested with various possible users.</td>
</tr>
<tr>
<td>Q.11.</td>
<td>Now:</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>Q.12.</td>
<td>Two years ago:</td>
</tr>
</tbody>
</table>

No identified customer can confirm the product’s usefulness. Various identified customers can confirm the product’s usefulness.

<table>
<thead>
<tr>
<th>Q.13.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.14.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

The Market

<table>
<thead>
<tr>
<th>Q.15.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.16.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

The company has no limitations on the customer categories to which it should sell. The company sells to a very specific customer category.

<table>
<thead>
<tr>
<th>Q.17.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.18.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

It is difficult to say what characterises the company’s customers who have the greatest likelihood of purchasing from the company. There are a number of criteria that define exactly the potential customers who have the greatest likelihood of purchasing from the company.

<table>
<thead>
<tr>
<th>Q.19.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.20.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

The usefulness that the company’s products can give to customers is built on assumption from within the company. Usefulness of the product to the customer is fully specified after contact with the customer.

<table>
<thead>
<tr>
<th>Q.21.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.22.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

The market is cultivated primarily through random contacts. The company works with a structured strategy for market cultivation.

<table>
<thead>
<tr>
<th>Q.23.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.24.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

The company cultivates a large number of customer categories. The company makes a clear prioritisation of certain customer categories over others.

<table>
<thead>
<tr>
<th>Q.25.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.26.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

Organisation

<table>
<thead>
<tr>
<th>Q.27.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.28.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

All staff do most types of tasks. All staff have clearly demarcated tasks.

There are no specific organisational units. The company can clearly be described in an organisational chart.

<table>
<thead>
<tr>
<th>Q.29.</th>
<th>Now:</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.30.</td>
<td>Two years ago:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

The staff were recruited from the founder’s personal network of contacts. Staff in the company were deliberately recruited for their special skills.
Q.29. **Now:** 1 2 3 4 5 6 7  
Q.30. **Two years ago:** 1 2 3 4 5 6 7

<table>
<thead>
<tr>
<th>The company’s activities derive from reactions to situations and events.</th>
<th>There is disciplined and goal-oriented work to develop the company.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.31. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.32. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Everybody in the company has responsibility for most of the activities involved.</td>
<td>There is a clear division of authority and responsibility in the company.</td>
</tr>
<tr>
<td>Q.33. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.34. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

**Expertise and competencies**

<table>
<thead>
<tr>
<th>The company lacks knowledge about the markets for its products.</th>
<th>The company is very well supplied with knowledge about the markets for its products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.35. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.36. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>The company lacks expertise in marketing and sales</td>
<td>The company is very well supplied with expertise in marketing and sales</td>
</tr>
<tr>
<td>Q.37. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.38. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>The company lacks the specific competencies needed in its field.</td>
<td>The company is very well supplied with peak expertise in its field.</td>
</tr>
<tr>
<td>Q.39. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.40. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>There is a lack of leadership experience and expertise in the company.</td>
<td>The company is very well supplied with leadership experience and expertise.</td>
</tr>
<tr>
<td>Q.41. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.42. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>The technical expertise that exists in the company doesn’t cover its needs for the future.</td>
<td>The technical expertise that exists in the company completely covers its needs for the future.</td>
</tr>
<tr>
<td>Q.43. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.44. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Every staff member is responsible for the development of his own expertise and competencies.</td>
<td>There is a planned and systematic development of expertise and competencies for each individual staff member.</td>
</tr>
<tr>
<td>Q.45. <strong>Now:</strong> 1 2 3 4 5 6 7</td>
<td>Q.46. <strong>Two years ago:</strong> 1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>
### Driving Forces

<table>
<thead>
<tr>
<th>Question</th>
<th>Now</th>
<th>Two years ago</th>
<th>Now</th>
<th>Two years ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.47.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Q.48.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

The founder’s foremost aim with the company is to create employment for himself and possibly some friends.

The founder’s foremost aim with the company is to “surprise the world” and build a growing company.

### Customer Relations

<table>
<thead>
<tr>
<th>Question</th>
<th>Now</th>
<th>Two years ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.53.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Q.54.</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

The company has not yet sold any products or services to any customers.

The company has a large number of customers who have bought its products or services.

### Other Relationships

<table>
<thead>
<tr>
<th>Question</th>
<th>Now</th>
<th>Two years ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.63.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Q.64.</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

There are no relationships with banks and investors.

There are good and firm relationships with banks and investors.
The company is lacking in capital.  

| Q.65.   | **Now:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q.66.   | **Two years ago:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

The company has access to all the capital that it needs for the company’s present and likely future activities.

| Q.66.   | **Now:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q.66.   | **Two years ago:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

There are no external contacts which can add to the company’s "credibility" in the eyes of the market.

| Q.67.   | **Now:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q.68.   | **Two years ago:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

The company has good contacts with government, which strengthen its "credibility" in the market.

| Q.67.   | **Now:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q.68.   | **Two years ago:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

The company has no external contacts or sources who can bring to the company extra management expertise.

| Q.69.   | **Now:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q.70.   | **Two years ago:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

The company has good external contacts and sources that bring to it extra management expertise.

| Q.69.   | **Now:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q.70.   | **Two years ago:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
Table 1  Australian case study sample: Cornerstone mean scores Now (at the time of questionnaire completion)

<table>
<thead>
<tr>
<th>No.</th>
<th>Idea</th>
<th>Product</th>
<th>The Market</th>
<th>Organisation</th>
<th>Expertise</th>
<th>Driving forces</th>
<th>Customer relations</th>
<th>Other relations</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.00</td>
<td>7.00</td>
<td>6.00</td>
<td>6.80</td>
<td>5.83</td>
<td>6.33</td>
<td>5.20</td>
<td>6.75</td>
<td>6.24</td>
</tr>
<tr>
<td>2</td>
<td>5.00</td>
<td>5.33</td>
<td>5.00</td>
<td>5.00</td>
<td>4.50</td>
<td>6.67</td>
<td>4.40</td>
<td>4.75</td>
<td>5.08</td>
</tr>
<tr>
<td>3</td>
<td>6.25</td>
<td>5.33</td>
<td>4.80</td>
<td>4.80</td>
<td>4.33</td>
<td>6.33</td>
<td>3.80</td>
<td>4.00</td>
<td>4.96</td>
</tr>
<tr>
<td>4</td>
<td>4.75</td>
<td>6.33</td>
<td>5.60</td>
<td>5.20</td>
<td>5.17</td>
<td>6.00</td>
<td>5.20</td>
<td>3.50</td>
<td>5.22</td>
</tr>
<tr>
<td>5</td>
<td>6.00</td>
<td>5.00</td>
<td>6.20</td>
<td>7.00</td>
<td>5.67</td>
<td>5.00</td>
<td>2.80</td>
<td>5.25</td>
<td>5.36</td>
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<td>6.67</td>
<td>7.00</td>
<td>5.40</td>
<td>5.33</td>
<td>5.00</td>
<td>2.80</td>
<td>6.75</td>
<td>5.71</td>
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<td>7</td>
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<td>1.00</td>
<td>3.20</td>
<td>5.80</td>
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<td>6.33</td>
<td>3.40</td>
<td>5.50</td>
<td>4.30</td>
</tr>
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<td>8</td>
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<td>5.00</td>
<td>6.60</td>
<td>2.20</td>
<td>3.50</td>
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<td>1.00</td>
<td>4.75</td>
<td>4.34</td>
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<td>5.80</td>
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<td>4.60</td>
<td>6.00</td>
<td>4.95</td>
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<td>5.33</td>
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<td>6.40</td>
<td>4.50</td>
<td>6.00</td>
<td>3.80</td>
<td>5.00</td>
<td>5.39</td>
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<td>4.15</td>
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<td>3.33</td>
<td>3.60</td>
<td>1.50</td>
<td>4.46</td>
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<td>5.40</td>
<td>5.00</td>
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<td>4.20</td>
<td>4.50</td>
<td>5.17</td>
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<td>6.33</td>
<td>6.80</td>
<td>6.20</td>
<td>6.00</td>
<td>4.67</td>
<td>2.40</td>
<td>5.25</td>
<td>5.58</td>
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<td>3.50</td>
<td>4.33</td>
<td>5.20</td>
<td>5.60</td>
<td>3.67</td>
<td>3.00</td>
<td>3.80</td>
<td>3.75</td>
<td>4.11</td>
</tr>
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<td>4.80</td>
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<td>5.50</td>
<td>5.67</td>
<td>5.60</td>
<td>4.25</td>
<td>5.57</td>
</tr>
<tr>
<td>22</td>
<td>4.75</td>
<td>3.67</td>
<td>4.60</td>
<td>4.20</td>
<td>2.33</td>
<td>6.67</td>
<td>3.80</td>
<td>1.25</td>
<td>3.91</td>
</tr>
<tr>
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<td>5.25</td>
<td>6.33</td>
<td>6.20</td>
<td>6.00</td>
<td>4.67</td>
<td>4.67</td>
<td>4.60</td>
<td>3.50</td>
<td>5.15</td>
</tr>
<tr>
<td>25</td>
<td>5.50</td>
<td>6.33</td>
<td>5.40</td>
<td>6.40</td>
<td>5.17</td>
<td>5.67</td>
<td>2.80</td>
<td>5.00</td>
<td>5.28</td>
</tr>
<tr>
<td>27</td>
<td>7.00</td>
<td>7.00</td>
<td>6.00</td>
<td>5.60</td>
<td>5.00</td>
<td>6.00</td>
<td>4.60</td>
<td>4.00</td>
<td>5.65</td>
</tr>
<tr>
<td>28</td>
<td>6.00</td>
<td>7.00</td>
<td>6.40</td>
<td>4.60</td>
<td>5.50</td>
<td>4.67</td>
<td>3.80</td>
<td>3.25</td>
<td>5.15</td>
</tr>
<tr>
<td>29</td>
<td>5.00</td>
<td>1.67</td>
<td>4.80</td>
<td>3.80</td>
<td>3.00</td>
<td>5.33</td>
<td>1.00</td>
<td>2.75</td>
<td>3.42</td>
</tr>
<tr>
<td>Cornerstone mean</td>
<td>5.54</td>
<td>5.19</td>
<td>5.52</td>
<td>5.31</td>
<td>4.67</td>
<td>5.41</td>
<td>3.51</td>
<td>4.32</td>
<td>4.93</td>
</tr>
<tr>
<td>Company X(1)</td>
<td>6.75</td>
<td>7.00</td>
<td>6.80</td>
<td>6.60</td>
<td>6.00</td>
<td>6.67</td>
<td>6.00</td>
<td>6.50</td>
<td>6.54</td>
</tr>
</tbody>
</table>

Note (1): Company X was an established publicly listed pharmaceutical company.
Source: Case study reports (Yencken, 2005).
### Table 2 Interview comparisons: Group A Opportunity driven entrepreneurial ventures

<table>
<thead>
<tr>
<th>No.</th>
<th>Product or activity</th>
<th>Parent</th>
<th>Date of incorporation</th>
<th>Age at case study - months</th>
<th>Mean Corner - stone score</th>
<th>Age at recontact - months</th>
<th>Status June 2005</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Asset location hardware and software</td>
<td>University, medium / small</td>
<td>17/11/1995</td>
<td>72</td>
<td>4.93</td>
<td>NA</td>
<td>Ceased trading</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Glaucoma detection instrument</td>
<td>University, large</td>
<td>29/10/1999</td>
<td>37</td>
<td>5.70</td>
<td>67</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Specialised light alloy billets</td>
<td>CRC</td>
<td>1994</td>
<td>100</td>
<td>4.93</td>
<td>NA</td>
<td>No longer trading</td>
<td>Voluntary liquidation due to failure to obtain START grant</td>
</tr>
<tr>
<td>10</td>
<td>Robotic seabed drill</td>
<td>University, large</td>
<td>2/2/2001</td>
<td>15</td>
<td>No response</td>
<td>NA</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Neurological evaluation of advertising</td>
<td>University, medium / small</td>
<td>16/11/1998</td>
<td>51</td>
<td>4.46</td>
<td>NA</td>
<td>Liquidated</td>
<td>First sold to US company.</td>
</tr>
<tr>
<td>27</td>
<td>Waste water filtration</td>
<td>University, medium/smll</td>
<td>7/12/98</td>
<td>44</td>
<td>5.65</td>
<td>77</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Minituarised reflux pH probe</td>
<td>University, medium/smll</td>
<td>4/7/2000</td>
<td>24</td>
<td>5.15</td>
<td>57</td>
<td>Active</td>
<td></td>
</tr>
</tbody>
</table>

Source: Case studies of spin-off companies from universities and other public research agencies (Yencken, 2005).

### Table 3 Interview comparisons Group B Venture capital driven spin-off ventures

<table>
<thead>
<tr>
<th>No.</th>
<th>Product or activity</th>
<th>Parent</th>
<th>Date of incorporation</th>
<th>Age at case study (months)</th>
<th>Mean Corner - stone score</th>
<th>Age at recontact (months)</th>
<th>Status June 2005</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Nasal filter and particle measure</td>
<td>University, large</td>
<td>21/01/1998</td>
<td>51</td>
<td>5.39</td>
<td>NA</td>
<td>Liquidated</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Blood clotting factor</td>
<td>University, large</td>
<td>28/2/97</td>
<td>62</td>
<td>4.15</td>
<td>NA</td>
<td>Taken over by another biotech - nology company in 2004.</td>
<td>Increased potential product range</td>
</tr>
</tbody>
</table>

Source: Case studies of spin-off companies from universities and other public research agencies (Yencken, 2005)
<table>
<thead>
<tr>
<th>No.</th>
<th>Product or activity</th>
<th>Parent</th>
<th>Date of incorporation</th>
<th>Age at case study (months)</th>
<th>Mean Cornerstone score</th>
<th>Age at re-contact</th>
<th>Status June 2005</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Polymer adhesion</td>
<td>CSIRO</td>
<td>May 2002</td>
<td>Awaiting incorporation</td>
<td>4.91</td>
<td>NA</td>
<td>No longer trading</td>
<td>Voluntary liquidation March 2004</td>
</tr>
<tr>
<td>5</td>
<td>Pain killer drugs</td>
<td>University, large</td>
<td>13/2/98</td>
<td>14</td>
<td>4.91</td>
<td>87</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Stem cell therapy</td>
<td>University, large</td>
<td>12/7/2001</td>
<td>7</td>
<td>4.30</td>
<td>46</td>
<td>Active</td>
<td>Now based in Singapore</td>
</tr>
<tr>
<td>9</td>
<td>X-ray imaging</td>
<td>CSIRO</td>
<td>12/11/1996</td>
<td>64</td>
<td>4.95</td>
<td>NA</td>
<td>No longer active in Australia</td>
<td>Sold to overseas company</td>
</tr>
<tr>
<td>14</td>
<td>Fuel cells</td>
<td>CSIRO</td>
<td>27/2/1992</td>
<td>123</td>
<td>4.32</td>
<td>NA</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Biomedical polymers</td>
<td>CRC</td>
<td>8/7/1997</td>
<td>62</td>
<td>5.17</td>
<td>NA</td>
<td>Active</td>
<td>Sold to overseas company</td>
</tr>
<tr>
<td>18</td>
<td>Diagnostics</td>
<td>CRC</td>
<td>1987</td>
<td>180</td>
<td>5.58</td>
<td>NA</td>
<td>Active</td>
<td>Listed public company</td>
</tr>
<tr>
<td>20</td>
<td>Driver vision assistance</td>
<td>University, large</td>
<td>24/7/2000</td>
<td>25</td>
<td>5.57</td>
<td>58</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Pig growth improvement</td>
<td>CRC</td>
<td>1/6/2001</td>
<td>13</td>
<td>5.15</td>
<td>47</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Plastic fibre optics</td>
<td>CRC</td>
<td>2/5/2002</td>
<td>15</td>
<td>5.28</td>
<td>NA</td>
<td>Active</td>
<td>Set up by CRC spin-off</td>
</tr>
<tr>
<td>29</td>
<td>Very large scale data storage</td>
<td>University, small / medium</td>
<td>2/2/1999</td>
<td>42</td>
<td>3.42</td>
<td>NA</td>
<td>No longer trading</td>
<td>Failure due to high development cost and uncertainty about the technology</td>
</tr>
</tbody>
</table>

Source: Case studies of spin-off companies from universities and other public research agencies (Yencken, 2005)
Table 5  Status of Direct Research Spin-offs by year of establishment from Survey of Australian Universities

<table>
<thead>
<tr>
<th>Count of Company name</th>
<th>Year in which established</th>
<th>A Actively trading</th>
<th>B Not trading at present</th>
<th>NE No longer exists</th>
<th>NK Not known</th>
<th>S Sold in a trade sale</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 1995</td>
<td>No.</td>
<td>22</td>
<td>3</td>
<td>2</td>
<td>24</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>40</td>
<td>6</td>
<td>4</td>
<td>44</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>1995-97</td>
<td>No.</td>
<td>18</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>27</td>
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<td>%</td>
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<td>2</td>
<td>26</td>
<td>8</td>
<td>175</td>
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<td>70</td>
<td>10</td>
<td>1</td>
<td>15</td>
<td>4</td>
<td>100</td>
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Table 6  Survival rates for university and CSIRO spin-offs: FY 2000 to FY2005

<table>
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<tr>
<th>Status / Parent</th>
<th>Active</th>
<th>Active in new ownership</th>
<th>Liquidated</th>
<th>Inactive</th>
<th>Total</th>
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<td>%</td>
<td>58</td>
<td>10</td>
<td>22</td>
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<tr>
<td>CSIRO</td>
<td>No.</td>
<td>6</td>
<td>6</td>
<td></td>
<td>12</td>
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<tr>
<td></td>
<td>%</td>
<td>50</td>
<td>50</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Review by the present authors of spin-off companies listed in ARC/NHMRC/CSIRO, 2001
**Figure 1** Cornerstone scores in Swedish survey (Maximum score 5)

Source: Data from Davidsson and Klofsten, 2003:14.

**Figure 2** Sample mean scores for Business Platform Cornerstones

Source: Case studies of spin-off companies (Yencken, 2005:149)
Figure 3  Cornerstone mean scores: Established company ‘X’

Source: Data collected by present authors.

Figure 4  Cornerstones mean scores: Company No.1

Source: Case studies of spin-off companies (Yencken, 2005)
Fifth High Technology Small Firms Conference
University of Twente, Enschede, The Netherlands

Title

Incentives to academic commercialisation activity and mixed signals about identity in researchers’ perceptions of utility

Author:
John Yencken, MA(Cantab.), PhD (Swinburne)
Adjunct Research Fellow
Australian Graduate School of Entrepreneurship
Swinburne University of Technology
PO Box 218
HAWTHORN VIC 3122.
AUSTRALIA.

Phone (03) 9214 5870
FAX (03) 9214 8381
E-mail jyencken@groupwise.swin.edu.au.
Incentives to academic commercialisation activity and mixed signals about identity in researchers’ perceptions of utility

Abstract

Akerlof and Kranton have analysed for a number of people and situations ‘their motivations in terms of the identities of members of the organization, where workers lose or gain utility insofar as their behaviour matches the ideal for their social identity’. They have proposed a utility function that incorporates ‘identity as a motivation for behavior’. They have postulated identity as being based on social categories. Their utility function provides both for each person to assign people to these categories with each person having a conception of their own and of other people’s categories. They then add the concept of prescriptions (recognizing that other scholars may have tended to call these norms) that indicate the behaviour appropriate for people in different social categories in different situations. They use the word identity ‘to describe both a person’s self image as well as her assigned categories’

This paper has drawn on data collected during a consultancy involving the author for the Australian Government Department of Education, Science and Training. This study explored incentives and disincentives to academic researchers to commercialise their research outcomes and their impact on university research commercialisation performance. This consultancy identified confused signals about identity as important disincentives. Such confusion has derived from a number of issues, including lack of effective recognition of commercialisation activity in reward and promotion systems and lack of time available to younger academics after fulfilling their teaching, publication and administrative responsibilities. The study also found that in publicly funded universities financial incentives, such as access to a share of royalties, were classic Herzberg hygiene factors. Royalty sharing had to be available but increasing the royalty share was unlikely to affect commercialisation performance.

The present paper has explored the relevance of Akerlof and Kranton’s concept of identity as a tool to analyse the motivation of academic researchers to commercialise their research outcomes. It has sought to analyse how the motivation of a researcher to divert time and mental effort to commercialisation activities related to each individual’s conception of their own and each other’s categories (in the Akerlof and Karnton terminology), having regard to their institutional environment and the prescriptions that are seen by the researchers and by others in their environments to determine appropriate behaviour. The first objective has been been to achieve improved understanding of incentives and disincentives motivating or demotivating academic researchers to commercialise their research outcomes. The analysis, as a secondary objective, has sought to evaluate the likely impact on commercialisation motivation of the implementation of Research Quality Frameworks (RQF) as the methodology for determining access to research funding by Australian universities. The RQF proposal is being designed to take into account the impact of research as well as its quality based on quality of publications. However, it concludes that the implementation of RQF in Australia is likely to seriously weaken the motivation of academic researchers (under increased pressure from university research managers on research quality related effort) to devote effort to commercialization unless new incentives and related initiatives are introduced. Finally, the research has been designed to answer the question raised by Akerlof and Kranton: ‘If monetary incentives do not work, what does?’

Key words: Commercialisation, incentives, identity, research, utility
Acknowledgement

This paper has drawn heavily on the 2004 consultancy report by Karingal Consultants, with authors John Yencken and Liss Ralston, entitled Evaluation of Incentives for Commercialisation of Research in Australian Universities: A survey of selected Australian universities, which resulted from a consultancy study for the Australian Commonwealth Department of Education, Science and Training (Yencken and Ralston, 2005). The author wishes to acknowledge the approval of the Department to quote material from the above report, the copyright for which is owned by the Commonwealth of Australia. An earlier version of this paper was presented at the Monash University Australian Centre for Research into Employment and Work “Shifting the Boundaries of Employment and Work” in June 2005.

Introduction

International economic integration, on the liberal view, is what happens when technology allows people to pursue their own goals and they are given the liberty to do so…Adam Smith’s invisible hand does its work. People choose what serves their self-interest, each of them making that judgement for himself (herself). The result is that society as a whole prospers and advances—spontaneously, not by design of any person or government (Economist, 2001, present author’s italics).

Innovation is not just the idea—innovation is only achieved when the idea has been transferred into an outcome which has value (Livingstone, 2000).

The translation of knowledge into economic activity has emerged as a recognised university function, alongside research and teaching (Etzkowitz and Leyesdorff, 1997: 1).

The quotations set out above show the changing attitudes in the world’s developed economies to the role of universities not only as generators of new knowledge, but also as key participants and intermediaries in ensuring the effective exploitation of the new knowledge so generated for the economic, social and environmental benefit of the communities involved. This can result either directly with the universities as resources for both new knowledge generation and technology transfer or more indirectly through the economic processes of globalisation and technology diffusion. The research reported in this paper has suggested that for Australian universities, as for many overseas universities, the process of organisational learning how to integrate these new emphases on the exploitation, not just the generation, of new knowledge, into university resource management and academic staff award and career development systems has for many been difficult. The research identified problems of deep trust and perceptions that despite formal change in, for example, promotion protocols entrenched historical attitudes still continue to result in a lesser credit for performance in the exploitation of new knowledge than in the traditional measures of research performance such as peer refereed publications and citation indices. We will discuss later in the paper what we have called confused signals about identity and the application in this context of Akerlof and Kranton’s (2000) work on economics and identity.

University strategies, performance measurement, incentives and disincentives

Acceptance of these propositions has implications for university governing bodies. They need to have in place valid strategies for the exploitation and commercialisation of the new knowledge and new technologies that their investment in research and development generates (Cripps et al., 1999; Wright et al., 2002). This in turn requires that they establish valid
quantitative objectives against which performance in the achievement and distribution of benefit from the investment in the creation of new knowledge can be measured.

Once such measurable key performance indicators (KPIs) have been agreed, university managements need to consider the incentives and disincentives that are likely to affect the commercialisation commitment and performance of the individual academic researcher. At the same time managements have to recognise that academic researchers have traditionally been recruited, rewarded and promoted for the excellence of their teaching, research and, for some, administrative skills. The need for, commitment to and performance in the commercialisation of their research outcomes, important now for some but usually not all, is relatively new and is not always adequately recognised in academic career development and reward systems. Recent studies in the UK and Australia have shown that for many, particularly younger academics needing publications to establish their academic careers, there is little or no time left after they meet what they see as their primary responsibilities to teaching and research (Cripps et al, 1999; Howard Partners, 2002; Wright et al., 2002).

The organisational environment therefore in which incentives and disincentives will be considered is complicated and there is no strong a priori case that financial incentives, either alone or at all, are likely to be effective in increasing commitment to research outcomes commercialisation as only one of the activities in which the staff concerned may be involved and on which their performance will be assessed. The literature on the effectiveness of financial incentives to management may have only limited relevance. There will be a need to consider other types of incentives that provide perceived benefit to the academic researcher across the totality of his or her career commitments: teaching, research, publications, administration, career progression generally.

The research reported here will show that while a perceived fair level of participation in royalties and other income derived from commercialisation of research outcomes is essential, this is essentially a Herzberg hygiene factor (Yencken and Ralston, 2005). The effective incentive to an academic researcher to increase his commercialisation commitment is to have access close by to sufficient support so that he or she does not have to commit scarce time resources to commercialisation activities such as intellectual property protection, business planning or deal making, activities in which he or she will usually have little skill or experience. In Akerlof’s terms, university administrations need to recognize the need for positive contributions, not just confused signals, to identity to optimize researchers’ perceptions of utility arising from the commercialization process. The danger is always that good researchers might be turned into poor entrepreneurs.

Confused signals about identity

Akerlof and Kranton (2000:1) have introduced “identity—a person’s sense of self—into economic analysis”.

We incorporate identity into a general model of behavior, then demonstrate how identity influences economic outcomes.

They have shown how the concept of identity expands economic analysis:

First, identity can explain behavior that appears detrimental…

Second, identity underlies a new externality. One person’s actions can have meaning for and evoke responses in others…
Third, identity reveals a new way that preferences can be changed. Notions of identity evolve within a society and some in society have incentives to manipulate them…

Fourth, because identity is fundamental to behavior, choice of identity may be the most important “economic” decision people make… (p.716)

Their utility function is based on categories, C.

Each person, j, has an assignment of people in these categories, so that each person has a conception of her own category and that of all other people. Prescriptions, P, indicate the behavior appropriate for people in different social categories in different situations”.

We propose the following utility function:

\[ U_j = U_j(a_j, a_{-j}, I_j) \]

Utility depends on j’s identity or self-image, Ij, as well as on the usual vectors of j’s actions, aj, and others’ actions, a-j. Since a and a-j determine j’s consumption of goods and services, these arguments are sufficient to capture the standard economics of own actions and externalities.

Following our discussion above, we propose the following representation of Ij:

\[ I_j = I_j(a_j, a_{-j}, c_j, e_j, P). \]

A person j’s identity depends first of all on j’s assigned categories, c_j. The social status of category is given by the function \( I(\bullet) \) and a person assigned a category with a higher social status may enjoy an enhanced self-image. Identity depends further on the extent to which j’s own given characteristics, \( e_j \), match the ideal of j’s assigned category, indicated by the prescriptions, P. Finally identity depends on the extent to which j’s own and others’ actions correspond to prescribed behavior indicated by P. We call increases or decreases in utility that derive from I, gains or losses in identity (p.718).

Akerlof and Kranton (2000) discussed the application of these concepts of utility and identity in a number of situations, including gender in the workplace, behavior of school children and poverty and social exclusion. These concepts will be applied later in this paper in exploring the relationships between academic researchers and academic administrators in their attitudes to commercialization of university research outcomes.

**Incentives and disincentives**

A full literature review on incentives to academic researchers was carried out as part of a consultancy report for the Commonwealth Department of Education, Science and Training (Yencken and Ralston, 2005). Approval has been sought and given for the use of extracts from this report.

This literature has explored the effectiveness of incentives generally where there has been a quite direct relationship between the individual or incentive group performance and that individual or group’s contribution to an identified commercial outcome. In a university environment, commitment to research commercialisation activity is only one of the several differing commitments required of the academic researcher and which will determine his career progress. Similarly there will be a much greater variability in the time between the researcher committing to a commercialisation activity and the parent university receiving commercial benefit from such commitment.
Incentives for knowledge workers such as academic researchers

Yencken and Ralston (2005) generated a list (Table 1) of possible tangible and intangible incentives that might be available to knowledge workers such as academic researchers.

**Tangible monetary incentives**

The Yencken and Ralston’s (2005) review showed that almost all the literature that formally addresses incentives for commercialisation has been focussed in four areas:

- The share to the inventor of net commercialisation proceeds and equity in spin-off companies that best promotes researcher commercialisation activity.
- Payment by the university of IP protection costs.
- Providing increased access to pre-seed finance (preferably without the need to incorporate the new venture) through mechanisms, internal and external to the university, for technology development, proof of concept and other pre-seed funding needs, such as IP protection and the market and competitor intelligence needed to assess the commercial opportunity and later develop the first business plan.
- Subsidised access to second tranche early stage venture capital.

There was no evidence of direct and immediate cash rewards for commercialisation performance (eg for disclosure of a new commercially attractive opportunity).

**Inventor share of commercialisation proceeds**

The commonly quoted inventor share of commercialisation net proceeds (royalties and sale of equity) was 30 per cent (Auril/UUK/Patent Office, 2002). However Lach and Schankerman (2003) have indicated that a much higher share of royalty income (but not usually other commercialisation income) was common in US universities. A recent comment from the experience of the University of Auckland (Rotherham, 2002) illustrates the problem of meeting the aspirations of academic staff:

Some researchers are unhappy with a one-third share of a spin-off company and think that they should get 100 per cent, Kernahan says, and they get more upset when their shareholding gets diluted as commercial partners put in capital to take the invention to market. Ten per cent of a company worth $1 million is better than 30% of one worth $100,000, but New Zealanders don’t tend to see that — they always think about control.

**Intangible commercialisation incentives**

Yencken and Ralston (2005) identified intangible incentives (Table 1) that included

- a supportive University culture and commercialisation strategy
- the importance of trust. The offer of increased incentives will not be effective if the target groups do not trust the institution’s willingness and ability to deliver on them.
- reward and promotion systems, that could be incentive or disincentive

**The risks to avoid**

Recent discussions have drawn attention to two caveats:

- Personal incentives to academic research staff must be aligned to incentives for the business, that is the University.
• The problem of toxic revenue: just enough finance to get a spin-off company started but not enough to make it sustainable. This usually results in failure or at best equity disposal at a very low valuation.

A recent survey involving the UK Patent Office (Auril, UUK and Patent Office, 2002) has also commented:

• Incentive structures need not be restricted to financial benefits. Support for academic staff engaged in IP commercialisation, and consideration of IP-related activities, as a criterion for promotion can also be important.

• Equity stakes may not be the best way of compensating departments for the temporary loss of staff to spin-outs, and more direct and immediate financial compensation should also be considered (eg buying out of teaching time or relieving researchers of administrative responsibilities).

Disincentives in university systems

The disincentives are firstly the lack of supportive university strategies, plans and resources and reward and promotion systems that do not reward and may discourage researcher involvement in commercialisation activity.

The importance of time

Australian studies (Cripps et al., 1999; Johnson, Matthews and Dodgson, 2001; Howard Partners, 2002; Yencken and Ralston, 2005) have identified time as probably the most serious barrier to academic involvement in research commercialisation activity in Australia. Increased teaching loads and the need to generate sufficient refereed publications particularly have limited the incentive to younger academics, even if they would like to be involved in the commercialisation of their research.

The UNICO/NBS survey (Wright et al., 2002: 29) came to a similar conclusion in the UK about time in relation to technology transfer offices. Wright et al. (2002) showed that in the majority of UK universities a significant impediment to the commercialisation of university IP is the non-availability of incentives and rewards for university staff to spend time on spin-outs and licensing.

The effectiveness of incentives

European Commission (EU) reports on best practice in the transfer of university technology to industry have in the past focussed almost solely on the organisational implications and models and not at all on the incentivisation of the individuals involved (INNO, 96). The Yencken and Ralston (2005) literature search did however identify several major studies of the effectiveness of financial incentives to academic researchers. The most recent has been the Lach and Shankerman (2003) econometric study of Incentives and Inventions in Universities. The Abstract to this paper states:

As Lazear points out in his important study of pay and productivity (2000:1346), “a cornerstone of the theory of personnel compensation is that workers respond to incentives”.

They claimed to show that economic incentives affected the number and commercial value of inventions generated in universities and that for 102 US universities during the period 1991-99 universities that gave higher royalty shares to academic research scientists generated more inventions and higher license income, while controlling other factors including university size, quality, research funding and technology licensing inputs. The incentive effects that they
found were much larger in private universities than in public ones. The incentive effect, particularly in private universities, appeared to work both through the level of effort and sorting of academic scientists. “This finding is important because it implies that the design of intellectual property rights and other forms of incentives in academic institutions can have real effects”. (Lach and Shankerman, 2003:27).

Three qualifying findings from this study are relevant to the Australian environment:

1. The incentives effect was much greater in private than in public universities. All the Australian universities in the Group of Eight and ATN are in the category of public universities and therefore the incentive effect might be expected to be lower. The most important finding is that royalty shares have positive, and significant, incentive effects both for public and private universities (significant at the 0.10 per cent level for public). However the incentive effect is four times as large for private institutions (Lach and Schankerman, 2003:15).

2. The effect of royalty share incentives on invention disclosure rates was positive (but less so than for royalty revenue) for private but negative for public institutions.

The differences in incentive effects on disclosures and on royalty revenue merit further discussion. These differences suggested firstly that incentives increase royalty revenue per disclosure. This in turn suggested that the impact on academic researchers of increasing royalty shares as financial incentives was to generate increased commitment and effort from the researcher in the stages after invention disclosure rather than in increasing awareness of a potentially commercialisable opportunity (Yencken and Ralston, 2005).

The other recent paper on financial incentives with a whole chapter on the subject identified in the Yencken and Ralston study has been the recent UK Patent Office review of managing IP in universities (Auril/UUK/Patent Office, 2002). It was to some extent limited by its focus on earnings from licensing of intellectual property and did not directly address incentives related to the broader issues of building and maintaining research-user relationships and generation of new spin-off ventures.

The purpose of inventor incentives is to promote directly the generation and exploitation of IP, but there are important issues relating to other staff [other than the academic inventors] in the department or unit. They may, for example, have assumed higher teaching or management loads, freeing up the time of those directly involved in the invention and, more generally they are part of the academic community. It needs to be clear however, that if a reward is made to participants (who are non-inventors), then this does not accord joint inventor status; otherwise further disputes could arise (p.62).

The UK Patent Office review collected details of IP related incentives in seven UK universities. They noted that some university achieved such equity in rewards by allocating a share of exploitation revenue to the department in question. The review suggested about 30 per cent as the appropriate revenue share to faculty or school.

Di Gregorio and Shane (2003) have studied the effects of a number of factors in new spin-off venture creation (as opposed to licensing IP to existing companies) by the most active US research universities. They concluded:

…we find evidence that several university technology transfer policies enhance start-up activity. In particular a low inventor share of royalties and a willingness
to make equity investments in TLO start-up companies increase start-up activities (Di Gregorio and Shane, 2003:225).

Yencken and Ralston noted these implications:

Understanding the implications of these policy tools is also important because they may generate conflicting incentives. In particular, many universities distribute a high percentage of their royalties to inventors in order to encourage the reporting and exploitation of inventions; however our results suggest that high distribution rates also serve as a disincentive to the creation of start-up firms. (Di Gregorio and Shane, 2003:225).

Siegel et al., (2002) revealed palpable differences in these areas that can potentially impede technology transfer. Many universities do not reward activities, such as commercialising research and creating new spin-offs, in their promotion and tenure decisions (Siegel et al., 2002). In John Nutt’s (2001) report on the Australian Academy of Technological Sciences and Engineering Workshop on Commercialising Innovation – The Second Step, he commented that “a number of speakers highlighted the lack of incentives, ranging from rewarding researchers, to providing resources for commercialisation”. Another commented that “Australian tax laws needed to be amended to tax options and equity at the time when added value is achieved”. Similarly academic administrators have seen the need for change:

It is important that universities recognise the value of applied research and reward people who make significant contributions. There need to be incentives for the exploitation of commercially related research (Professor Andrew Glenn, Pro Vice-Chancellor (Research), University of Tasmania).

Research findings for Australian universities

Data collection
The DEST consultancy survey (Yencken and Ralston, 2005) involved three stages of data collection:

1. Interviews with Deputy or Pro Vice-Chancellors Research at all Group of Eight and Australian Technology Network universities.
2. Mail survey and follow up with managers of the technology transfer offices of these thirteen universities.
3. Focus group discussions and an E-mail based survey of academic researchers in these universities.

Commercialisation performance data was also presented as in Figure 2.

Research findings
The survey found there was a commitment to an effective research commercialisation strategy by senior management in most of the top performing (in terms of research commercialisation) universities. The most important categories of incentives identified were:

---

1 US universities commonly limit researcher revenue share to royalties only, excluding proceeds from sale of equity and other commercialisation revenue.
• Financial returns, including access to a share of royalties and other commercialisation net revenue, generally shared equally between the university, the research centre or faculty and the inventors, access to equity in spin-off companies (most commonly around 25 per cent). Taxation issues were a major issue for researchers both in actually deciding to take up equity offers and in determining the exact form (shares, options, etc.) in which the equity was offered. This issue has been further explored in a recent review of IP related taxation issues by the University of Melbourne Law School (Ryder et al., 2006)

• Support mechanisms, particularly the provision of business development staff and resources, both to help identify commercialisation opportunities and provide support and relief to inventors in the early stages of the new opportunity’s commercialisation and development. These enable inventors to better balance their research endeavours without detriment to their academic careers and other responsibilities.

This support is usually quite critical in providing access to the commercial and market related skills and experience that have been identified by in Flanders as a key factor in the generation of new technology based high growth ventures. (Heirman and Charysse, 2004)

• Finance and other resources: provision of pre-seed and seed funding for technology development (proof of concept and working prototypes), funding support for intellectual property protection (including patents), and for market and competitor intelligence to allow business model development.

The Yencken and Ralston survey showed the importance of researchers being able to share in the proceeds arising from the commercialisation of their research, but with some qualifying comment:

Six out the Group of Eight Universities and three out of the five ATN universities indicated (in one way or another) sharing in the economic returns from research commercialisation as the single most effective incentive. Only one respondent specifically mentioned equity in spin-off companies. There was however a comment that “giving IP rights to staff has resulted in an increase in spin-out activity”.

Increasingly, access to a share of technology transfer and commercialisation net revenue and to equity in spin-offs had become hygiene factors. They were the norm and were expected. They were included in industrial relations agreements.

…such characteristics as business policy and administration, supervision, interpersonal relations, working conditions and income have been characterized by Herzberg as hygiene factors. When they are adequate, people will not be dissatisfied; however, neither will they be satisfied. If we want to motivate people on their jobs, Herzberg suggests emphasizing recognition, the work itself, responsibility and growth. These are the characteristics that people find intrinsically rewarding (Robbins et al., 1996: 251).

Lack of such [revenue sharing] arrangements would be a strong disincentive, but their presence and the shares going to researchers could no longer be seen on their own as effective incentives. Increasing the researcher’s share would be unlikely to increase commitment to commercialisation activity, but lack of trust and policy consistency in implementation would quickly become disincentives (Yencken and Ralston, 2005).
There was little or no support for more direct financial incentives, eg financial rewards for making a disclosure that ended in a patent, as has become common in some US publicly funded research agencies.

There was however unanimous agreement among the university senior managements (Deputy and Pro Vive-Chancellors, Research) interviewed that, while access to a share of royalties and other commercialisation revenue was the most important individual incentive, deployment of business development people in the faculties and research centres was the most effective incentive in improving both rate of disclosure generation and ongoing commercialisation commitment by researchers.

Disincentives to commercialisation
Many researchers interviewed were unaware what incentives were available, with very few aware how the cost deductions to reach a commercialisation net revenue figure were calculated. Among researchers, there was a quite widespread lack of trust in university administrations that the incentive reward would be paid as expected, particularly where changes had been made post hoc, generally to the disadvantage of the inventors or people involved in consultancies and research contracts.

The smaller research profile universities had difficulty in finding the financial and other resources needed to deploy suitably qualified and experienced business development staff, and had been unable to establish their own internal critical mass of commercialisation support. There was scope for ongoing State government assistance in this area.

Findings on identity and utility
This next analysis has followed the broad schema of Akerlof and Kranton’s study of identity issues in the consideration of poverty and social exclusion (Akerlof and Stanton, 2000: 741-746). In the case for this paper, we have called the researchers with a commitment and interest in the commercialization of their research outcomes the Greens and those who have no interest in research commercialization and are solely focused on research to generate new knowledge as assessed for peer reviewed publications the Reds. We will propose two types of activities: Activity One is the traditional academic role of teaching, research and some administration, and Activity Two is involvement in the commercialisation of research outcomes. We also need to consider the prescriptions involved. Both Reds and Greens will be expected both by themselves and by others to maintain a high level of commitment to teaching and research. The Greens will also have for themselves a prescription of ensuring the commercial exploitation of the new knowledge that they generate. There will also be different pecuniary externalities. The Greens are much more likely to be interested in improved financial remuneration deriving from their research commercialisation prescription.

The literature on university research commercialization shows that we also need two more categories, those who provide support in the commercialisation process, who we will call the Blues, and those who administer, make resource allocation and promotion decisions, who we will call the Greys. This last group will have among its prescriptions in terms of desired outcomes: financial solvency, research quantity and quality, and maximizing research funding from governments and other external agencies.

Outcomes or the dependent variable will be \( r \). \( r_{\text{opt}} \) will be the optimum level of commercialisation activity that maximises the perceived utility of the various groups. Three scenarios are illustrated in Figure 2:
Scenario 1: \( r_0 \) The university’s focus is solely on teaching and research and the University administrators provide no support for and no recognition in reward and promotion systems for research commercialization performance.

This has been the scenario in the past for many universities in Australia, UK and Europe. This scenario would apply if under the implementation of the proposed Research Quality Framework in Australia (DEST, 2005) research impact was to be measured solely by the citation indices of the researchers involved. The prescriptions of the Greys here reject the need for commercialization. This scenario satisfies the Reds’ prescriptions for themselves, but there can be significant loss of identity and hence reduced perceptions of economic utility by the Greens.

Scenario 2: \( r_m \). The university provides a limited level of support for the commercialisation of its research outcomes and there is some but an inadequate level of recognition for successful commercialisation performance in reward and promotion systems.

The Yencken and Ralston (2005) study has suggested that this is effectively the scenario that still applies in most Australian universities. The Greys do not see their organization as financially able to provide the necessary resources and the Green researchers have doubts about the extent of recognition of their commercialization performance in reward and promotion decisions, even where this was stated to be university policy. Reds identity is still protected and there is some improvement in Greens’ identity and perceptions of economic utility.

1. \( r_{\text{max}} \). The university provides a high level of support for researchers seeking to commercialise their research outcomes and reward and promotion systems reward superior commercialisation performance.

In Australia, the University of Queensland well illustrates the outcomes of such a set of prescriptions. In Figure 1, this University is the outlier when the number of licences options and agreements (LOAs) per $million of research expenditure is plotted. A similar pattern is found for other performance indicators, disclosures and spin-offs generated. The prescriptions of the Greys, the administrators from successive Vice Chancellors down have ranked commercialisation and exploitation of new knowledge generated very highly themselves, as they have in their prescriptions for their researchers. As a result, the identity and perceived economic utility of both researchers and those working in support of research commercialization is maximised.

Conclusions

The first set of conclusions relates to university commercialization processes. The literature and recent Australian research has shown that improving commercialisation performance has more to do with alleviating or removing disincentives than with direct financial incentives. Throughout the Yencken and Ralston research, as in previous studies in Australia and elsewhere quoted earlier, there was an almost unanimous emphasis on the importance of support close-by for commercialisation activities both to overcome the lack of time, particularly for more junior researchers still establishing their research status and to make available commercial and market related competencies.

There was a strong consensus among the focus group participants that the critical incentive was the close availability of support through access to business development people close-by. In the larger Group of Eight universities, this meant located in the faculty or research centre—even where in one university
such support was not available, survey participants would have welcomed such availability (Yencken and Ralston, 2005).

The effectiveness of such support has been well demonstrated by the top performing universities in terms of research commercialisation, as shown in Figure 1, Queensland, Monash, Sydney and Western Australia. The other more critical disincentive relates to access to small amounts of pre-seed funding. The findings of a recent Australian Institute of Commercialisation survey for DITR are relevant here (AIC, 2004).

From the results of this survey the existence of a gap in funding at the very early stage is verified by 87% of investors and 88% of clients. Respondents believe there is a demand for finance below $2.0M that is unmet by the current financial market. From comments provided by respondents, this is not necessarily only the result of a lack of available funding being available for specific equity investment, but also comprise a combination of several other issues.

The second set of conclusions relate to the relevance in this context of Akerlof and Kranton’s concepts of the contribution of identity to an individual’s perceptions of economic utility. Akerlof and Kranton (2000: 753) claim that ‘identity affects economic behavior in four ways’. Our conclusions show how this applies in the context of university research commercialisation:

1. **Identity changes the payoffs from one’s own actions.**

A researcher whose perceptions of his own identity and the associated prescription include the importance of exploiting and commercialising his research outcomes is more likely to obtain economic benefit from such activity.

2. **Identity changes the payoffs of others’ actions.**

The outstanding commercialisation performance of researchers at the University of Queensland (Figure 1) directly relates to the identity and prescriptions of its Vice Chancellors and senior administrators, both for themselves and for the University’s researchers.

3. **The choice, or lack of choice thereof, of different identities affects an individual’s economic behavior.**

A researcher for whom the perceptions of identity and prescriptions are limited to traditional measures of research performance, that is refereed publications, has a lack of choice about and will be less likely to get involved in the commercialisation of his research outcomes. However, when he is offered a choice, such as when one of his discoveries has real commercial value, his identity and prescriptions, based on experience from the author’s research, may change and affect his economic behaviour.

4. **The social categories and behavioral prescriptions can be changed, affecting identity based preferences.**

The changes seen in the research reported here mainly relate to changes in perceptions of identity and prescription for either one’s own or others’ perceptions of identity. The social categories have remained constant, while identity has changed.

REFERENCES


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Table 1 Classification of commercialisation incentives.

<table>
<thead>
<tr>
<th>Tangible monetary incentives:</th>
<th>Direct personal incentives</th>
<th>Removal and/or attenuation of barriers and mediating factors</th>
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<tbody>
<tr>
<td>Royalty/equity participation.</td>
<td>Tangible monetary incentives:</td>
<td>Royalty/equity participation.</td>
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<tr>
<td>Direct cash awards eg for new disclosures.</td>
<td>Direct personal incentives</td>
<td>Direct cash awards eg for new disclosures.</td>
</tr>
<tr>
<td>Recognition of patents and other commercialisation activity in university reward and promotion systems</td>
<td>Tangible monetary incentives:</td>
<td>Recognition of patents and other commercialisation activity in university reward and promotion systems</td>
</tr>
<tr>
<td>Additional research resources.</td>
<td>Direct personal incentives</td>
<td>Additional research resources.</td>
</tr>
<tr>
<td>Additional travel, equipment and similar expense provision</td>
<td>Tangible monetary incentives:</td>
<td>Additional travel, equipment and similar expense provision</td>
</tr>
<tr>
<td>Finance for IP related expenses.</td>
<td>Tangible monetary incentives:</td>
<td>Finance for IP related expenses.</td>
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<tr>
<td>Finance for market and competitor intelligence gathering.</td>
<td>Tangible monetary incentives:</td>
<td>Finance for market and competitor intelligence gathering.</td>
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<td>Pre-seed technology development (TD) stage finance to proof of concept</td>
<td>Tangible monetary incentives:</td>
<td>Pre-seed technology development (TD) stage finance to proof of concept</td>
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Intangible incentives
- Easy access to and support from business development people.
- More time for commercialisation, eg by buying out teaching time or relieving researchers of their administration responsibilities.
- Internal commercialisation support and mentoring.
- Flexible employment conditions, eg to allow short-term secondments and return without loss of promotion opportunities.
- Access to incubator Start House prior to incorporation of a new venture.

Intangible incentives
- Understanding that the university has a clear and transparent research utilisation and commercialisation strategy and associated policies and procedures.
- Speed in university decision making on commercialisation issues.
- Generating deep trust in university senior management decision-making.

Training
- Training in opportunity discovery (Siet, 2001).
- Training in IP management and protection.
- Improving understanding of the commercialisation process and new venture management.

Source: Yencken and Ralston, 2005.

Figure 1. LOAs as a measure of commercialisation performance

Source: Yencken and Ralston, 2005: 75.:
Figure 2  Identity and economic utility for commercialisation prescription scenarios

Source: Present author.