INTERNATIONAL TECHNOLOGY TRANSFER: BUILDING THEORY FROM A MULTIPLE CASE-STUDY IN THE AIRCRAFT INDUSTRY

Harm-Jan Steenhuis

Eastern Washington University

College of Business and Public Administration, Department of Management

668 N. Riverpoint Blvd. Suite A,

Spokane, WA 99202-1660, USA

Tel: 509-358-2283

Fax: 509-358-2267

E-mail: hsteenhuis@mail.ewu.edu

* Corresponding author

Erik J. de Bruijn

University of Twente

School of Business, Public Administration and Technology

PO Box 217

7500 AE Enschede, the Netherlands

Tel: +31-53-4893531

Fax: +31-53-4893087

E-mail: e.j.debruijn@utwente.nl

Paper presented at the Academy of Management Annual Meeting: A new vision of management in the 21st century, Honolulu, 2005, no. 1360

Abstract

International technology transfer occurs frequently in international operations, for example in cases of foreign direct investment where companies set-up existing manufacturing lines in new locations. It also occurs in situations of international outsourcing where a new supplier receives product and/or production process information. This technology transfer process often leads to difficulties, for example delays and much higher costs than anticipated. To gain insight into the causes of these difficulties we used a grounded theory approach to describe the process of international production technology transfer. We conducted four case studies in the aircraft industry and analyzed the problems that occurred. We found that technology transfer consists of three phases: preparation, installation and utilization. These three phases are influenced by three types of factors: technological, organizational and environmental. The combination of activities with factors enables an integrated view on international technology transfer. We found that the amount of technology, the accuracy of information, and the extent of organizational and environmental differences have a large impact on the efficiency of the technology transfer process.

Keywords: International operations, technology transfer, aircraft industry

International technology transfer: building theory from a multiple case-study in the aircraft industry

INTRODUCTION

Many businesses currently are involved in international operations and those which are not as yet, might be confronted with them shortly. For example, a survey by van Dam and Deitz (1995) showed that internalisation is the most important development for Dutch companies due to the increasing international competition, the existence of low-wage countries and the rise of Eastern Europe. Although low wages are important, Porter (1990) showed that countries can offer other competitive advantages as well. For example, the demand conditions for a product in a certain country may give competitors in that country a competitive advantage when they compete in other geographic markets. One of the consequences is that companies in international business have to consider alternative international production locations.

Although Porter (1990) identified the opportunities from producing in different geographic locations, he did not elaborate on how a technology or production line should be transferred. Yip (1992) also indicated the potentials of having a global strategy, identifying five strategy levers for companies. One of these levers is the global location of activities. Again, the potential for transferring technology is shown. Ferdows (1989) focused on the management of international manufacturing. He described different purposes for different production locations and some of the difficulties in managing overseas locations. Shi and Gregory (1998) indicated that the main outcome of globalization is international manufacturing networks. They identified seven types of manufacturing networks, with a trend towards geographically dispersed and horizontally co-ordinated factories. Overall, these authors indicate that there is a strategic potential in transferring activities across national borders, without detailing how such a technology transfer should be managed.

In practice, the transfer of technology encounters significant difficulties and it is often problematic. Several authors (Clifford, 1997; Lewis, 1998a; Mann, 1989; Moxon and Lewis, 1998) provide illustration of a number of problems with technology transfer leading to considerable losses and cancelled projects.

TECHNOLOGY TRANSFER LITERATURE

There are many different viewpoints on technology transfer. A first distinction can be made between vertical and horizontal transfer of technology. Ramanathan (1994, p. 253) describes them as ‘Vertical technology transfer represents a flow from laboratory research through developmental stages and ultimately to commercialization. Horizontal technology transfer is essentially the transfer of established technology from one operational environment to another. Steenhuis and de Boer (2002) distinguish at least 16 types of technology transfer. Their categories are based on the type of technology that is transferred in combination with the direction of the transfer, i.e. whether it occurs in a vertical or horizontal manner. From this point on, our focus is on horizontal transfer of production technology.

Several authors have used the perspective of multinational companies and emphasized the choice of technology, the channel of technology transfer related to the amount of control that can be exercised, and the cost of producing in other countries (Al-Ali, 1995; Al-Obaidi, 1993; Amsalem, 1983; Baranson, 1970; Hirsch, 1976; Hymer, 1976; Mansfield, 1975; Mansfield, Romeo, Schwartz, Teece, Wagner and Brach, 1982; Stobaugh and Wells, 1984; Teece, 1976; Teece, 1981;Tsang, 1997; Vernon and Wells, 1991). These focus on one, or at most a few, strategic issues and how decisions with regard to these have been made. For example Hirsch (1976) showed that the choice between export and foreign direct investment depends on the opportunity of a firm to take advantage of its firm specific know-how and the local production cost. Although the issues treated are fundamental for our understanding of the strategic decisions for multinational companies, they do not discuss the success or effectiveness of technology transfer.

Other authors have used the perspective of industrially developing countries and have studied the appropriateness of technology and the price industrially developing countries were or should be paying for technology (Bruun and Mefford, 1996; Cooper, 1973; Dahlman, Ross-Larson and Westphal, 1985; Madu, 1989; Marcelle, 2003; Stewart, 1979; UNCTAD, 1978; UNIDO, 1979; Wallender, 1979). These studies deal with a few issues for strategic decision making from an industrially developing country perspective. For example Madu (1989: 121) states that "the MNCs are blamed for transferring inappropriate technology. This is because the technology is often capital intensive and ill-suited to the local production needs". Although the issues treated are fundamental for our understanding of the strategic decisions from an industrially developing country perspective, they are limited in their scope.

Another strand of literature took a more comprehensive viewpoint by looking at the success of technology transfer, i.e. effectiveness, and identifying a combination of key factors (Agmon and von Glinow, 1991; Al-Ghailani and Moor, 1995; Chen, 1996; Djeflat, 1988; Godkin, 1988; Heston and Pack, 1981; Kumar, 1995; Mital, Girdhar and Mital, 2002; Perlmutter and Sagafi-nejad, 1981; Robinson, 1988; Rosenberg and Frischtak, 1985; Samli, 1985; Yin, 1992). These studies offer much more insight into the complexity of technology transfer and the numerous factors that influence the success of technology transfer, i.e. whether the receiving company is able to utilize the technology. For example, Samli (1985: 4-8) provides geographical, cultural, economic and government factors that influence successful technology transfer. Some factors have been identified as extremely important such as high culture differences (Hussain, 1998; Kedia and Bhagat, 1988) and tacit knowledge characteristics (Gorman, 2002; Grant and Gregory, 1997b; Howells, 1996; Marcotte and Niosi, 2000) both leading to difficulties in technology transfer. In general, these studies add to our understanding of the importance of a range of factors to the success of technology transfer. However, these studies treat factors as distinct and they do not relate them to specific activities. This leaves us with a collection of factors whose combined effects on technology transfer activities are not known. They also focus on effectiveness of technology transfer, i.e. was the technology transferred, rather than the efficiency of technology transfer, i.e. how many resources were required to transfer the technology.

Technology Transfer Process

Behrens and Hawranek (1991), Behrman en Wallender (1976), Dahlman and Westphal (1981), Chantramonklasri (1990) and Teece (1976) provide similar process models for technology transfer from industrially developed to industrially developing countries when a new facility is established. To illustrate the phases in these models, Behrman and Wallender's model (1976) will be discussed. Behrman and Wallender (1976: 5-14) identified seven phases for technology transfer within multinational companies to industrially developing countries when setting-up new factories. The first three phases occur prior to start-up of the plant and include (1) initiation of proposals for site location and planning of the operation, (2) making adaptations to the product designs, and (3) design and construction of the facilities. In the fourth phase, start-up activities, industrial engineering and training play an important role and this requires often a substantial number of personnel from the parent. In value engineering, the fifth phase, the focus of attention is shifted toward improving cost-effectiveness. In the sixth phase, product development, and the seventh phase, external support, the capabilities of the facility and its surrounding suppliers are improved. The last three phases of the model deal with continuous production management and the technology transfer, establishment of technology at a new location, can be considered to have ended at phase four. Behrman and Wallender (1976: 14-19) furthermore focus on transferring knowledge in these phases through mechanisms such as sharing of documents, instruction, conferences, visits, and sending of equipment. Behrman and Wallender provide illustrations to show the amount of effort required to transfer a technology. For example, to establish of a Ford plant in South Africa more than 53 experts were sent to South Africa (Behrman and Wallender, 1976: 52), around 150 local people were hired annually for the first couple of years (Behrman and Wallender, 1976: 65) and to train people for example for a supervisor position took 18 months due to low education levels (Behrman and Wallender, 1976: 67). Because of the emphasis chosen, the models from Behrens and Hawranek (1991), Behrman and Wallender (1976), Dahlman and Westphal (1981), Chantramonklasri (1990) and Teece (1976) are primarily focused on multinational companies who own and manage overseas operations and are setting-up new facilities. These models are not sufficient to describe the technology transfer process between two existing companies.

Kaplinsky (1990), Miles (1995) and Moustafa (1990) use the perspective of an industrially developing country. Their models describe similar phases. Moustafa (1990) will be used as an illustration. Moustafa (1990) identified five phases. In the first phase, choice of technology, the industrially developing country has to make a choice among different technological options. Activities included in this phase are evaluating current and future competitiveness of a firm, appraising the relative risk of developing versus acquiring technology, assessing the rate of future changes in technology, estimating potential return on investment in financial as well as in strategic terms on micro and macro levels, determining economic and financial viability, preparing preliminary engineering designs, and preparing technical specifications and evaluations. In the second phase a channel for transferring technology needs to be selected. This can for example be: licensed production, joint-venture or wholly-owned subsidiary. After these two phases the technology has to be adapted to the local conditions in the third phase. During the fourth phase, integration of the technology, the emphasis is on the manufacturing processes and assimilating the new technology into the company’s internal activities. The aim of the last phase, implementing and managing the technology, is to see if there is a self-sustaining and successful on-going operation in place and to manage this system. The models from Kaplinsky (1990), Miles (1995) and Moustafa (1990) use the perspective of the receiving company but essentially ignore the sending company.

Bar-Zakay’s (1972) technology transfer model describes a sequence of technology transfer activities that specifically combines the technology sender and receiver. The model has four phases: search, adaptation, implementation and maintenance. After each phase a joint-decision has to be made whether to terminate the project or carry on. Policies and priorities are developed in the search phase. Two criteria for continuing to the next phase are: compatibility of policies and priorities, and personal compatibility. The adaptation phase starts with the formulation of a technology transfer project or process. Activities to be carried include learning about the environments and evaluating the cost and feasibility. The major joint-decision criteria at the end of this phase are: degree of consensus on feasibility and desirability, and cost effectiveness commensurate with policies and priorities established in the search phase. The third stage covers the actual transfer. The sender has to provide training and overcome resistance to change while the receiver has to provide supporting elements and ensure bureaucratic support. The decision criteria are: identification of problems that require such changes in the technology transfer project that a completely different pilot operation is called for, and identification of problems that cannot be solved at the maintenance stage without excessive risk to either recipient or to both. Finally, at the maintenance stage, when the technology transfer project is in full-scale operation, the donor should delegate authority to the recipient. Criteria to evaluate the success or failure of the project are: original expectations versus current performance, and net benefits.

Legg (1991) studied potential technical, social and environmental problems that were likely to be encountered during the implementation of a technology transfer agreement. Legg used an in-depth approach to search for important factors in technology transfer projects between the UK and China. Legg found that the efficiency of a technology transfer process is influenced by technical system factors (poor quality of products and production delays), social system factors (for example skill shortages) and external influences (for example government influence). Legg (1991: 30) identified four basic phases in a technology transfer process: preparation for transfer, partner selection, negotiations and implementation. Grant (1997) linked the content and the process of international transfers of manufacturing using the perspective of the sending company. Grant differentiated between host dependent and host independent characteristics of the manufacturing process to facilitate the assessment of the relationship between manufacturing process and transfer implementation activities. Grant (1997) identified four transfer implementation activities: adaptation; packaging; resource, competence and capability building; and support. Grant and Gregory (1997a) identified robustness and transferability as constructs to determine the ease of the technology transfer process. A robust process can be transferred to any environment without adaptation, and will fit the local conditions. The transferability of a process is its innate, host-independent ability to be adapted, transmitted, and assimilated, within reasonable time and resource constraints. Grand and Gregory (1997a) found that if the process is robust and transferable, it is ideal for transfer. A non-robust and non-transferable process is the most difficult to transfer.

It can be concluded that most studies on technology transfer have focused on one or a few strategic decision factor or on identifying a range of factors that influence the effectiveness of technology transfer. Although a number of studies on the process of technology transfer exist, only a few of them have combined the activities for both sending and receiving companies. An interesting in-depth study is provided by Grant (1997). However, his study is mainly organized around 'sending a technology away'. This has an inherent disadvantage because the technology implementation will take place at the receiving company. Therefore, we believe that it is necessary to look at activities at a company that receives a technology. Our study, therefore, describes the process of technology transfer from the perspective of the receiving company.

METHODOLOGY

Research problem

The purpose of the research is to gain insight into the process of production technology transfer, i.e. to understand how production technology transfer takes place from the perspective of the receiving company. Production technology transfer frequently takes place between industrially developed nations and industrially developing nations, therefore, we were primarily interested in this type of transfer. The World Bank annually publishes a World Development Report in which it distinguishes four groups of countries: low-income economies, lower-middle-income economies, upper-middle-income economies and high-income economies. Our research focus was technology transfer between low-income or lower-middle-income economies and high-income countries.

Furthermore, there are many horizontal transfers of production technology and we choose to focus the research on one particular production technology, aircraft production technology. First, the technology is of prime importance in the transfer process. It is therefore necessary to develop in-depth knowledge about the technology. We therefore choose not to vary the technology. Second, aircraft manufacturing is an attractive industry to develop for industrializing countries. Lewis (1998b) describes China, Korea and Indonesia as countries which are trying to develop their aircraft industry. Third, Porter (1986; 1990) and Yip (1992) consider the aircraft industry as an extreme case of a global industry. Many aircraft manufacturers produce parts in different parts of the worlds, there are therefore potential technology transfer projects to study. We choose to focus on civil aircraft because it was unlikely that access can be received to military production plant. Second, the market (industry) for military aircraft is different than for civil aircraft. The differences in demand and ownership structures make that these types of technologies may not be comparable with non-military aircraft.

Based on these choices the central research problem was formulated as: What is the process by which civil aircraft production technology is transferred from companies in industrialized countries to companies in industrializing countries?

Research Approach

Our research orientation is what Miles & Huberman (1994: 4) call ‘transcendental realism’. This perspective is a mix of postpositivist and interpretivist thinking. On the one hand, as in the postpositivist perspective, we believe that social phenomena can be described by regularities and sequences that link together phenomena, i.e. probable facts or laws (Guba and Lincoln, 1994), but we do not use the deductive methodology of postpositivism (Guba and Lincoln, 1994). On the other hand, we agree with the interpretivist perspective as stated by Schwandt (1994: 118): “The world of lived reality and situation-specific meanings that constitute the general object of investigation is thought to be constructed by social actors. That is, particular actors, in particular places, at particular times, fashion meaning out of events and phenomena through prolonged, complex processes of social interaction involving history, language, and action. The interpretivist believes that to understand this world of meaning one must interpret it.” This calls for an inductive methodology. As Miles & Huberman (1994: 4) state it: “Unlike researchers in physics, we must contend with institutions, structures, practices, and conventions that people reproduce and transform. Human meanings and intentions are worked out within the frameworks of these social structures – structures that are invisible but nonetheless real.” In other words, in our approach we immerse ourselves in field situations, or cases, in order to be able to interpret the business processes. At the same time we look for commonalities and differences in different field situations and how these explain the outcomes of the technology transfer process in order to discover ‘natural laws’.

This transcendental realism perspective is very useful in operations management. Although according to Meredith (1998) in operations management positivism and the employment of quantitative methodologies have dominated, Meredith (1998: 453) states: “The case/field focus on understanding is preferable for new theory development in operations management because eventually, the explanation of quantitative findings and the construction of theory based on those findings will ultimately have to be based on qualitative understanding.”

Data Collection

Within case. The data collection within each case was driven by grounded theory principles to inductively discover how technology was transferred. At the beginning of the field study we developed a case study protocol. This case study protocol provided initial direction to the research by stating areas of interest combined with a first indication on where data might be found. We did not have a survey type list of questions to ask respondents, since this is not in accordance with the inductively oriented grounded theory methodology (Glaser and Strauss, 1967). Once the field study was initiated, continued data collection was directed by the constant comparison technique (Glaser and Strauss, 1967: 101-115). That is, data were continually compared and based on this the next type of data and source was determined. The data collection and analysis were written down in field notes, i.e. a database was established.

Our research focus was to discover the process of technology transfer and we were open to different potential research angles. During the research process, guided by comments from respondents and the availability of material, the focus became time-oriented. In other words, to discover the process of technology transfer, we examined how the technology transfer was originally planned and then followed-up with analyzing whether it went as planned and why or why not.

We used a combination of data collection methods. In each case, we studied *documentation* first because typically respondents initially reacted to our inquiries by giving us documentation to study. In the four cases, planning documents were first analyzed to get a sense of the activities in technology transfer and the accompanying schedule. The planning was then compared with other documentation such as progress reports and written communication such as faxes, letters etc. These data where then compared with data gained from *interviews* and *observations*. During the interviews respondents were asked, in an open format, about their ideas and opinions so that the meaning of the events could be determined. This frequently led to follow-up interviews to clarify emerging issues and also led to interviews with selected people in other positions in the companies to get their ‘side of the story’. For example, in the second case, during interviews with a Romanian manager he indicated that one of the difficulties with production technology transfer was that Romanian operators could not produce certain parts. He stated that this was not due to the skills of the Romanian employees, but rather because the drawings and process planning sheets of the Canadian company were of poor quality. When a Canadian foreign representative was subsequently interviewed about this same topic, surprisingly, the Canadian manager confirmed this viewpoint. This finding was surprising because the production of aircraft very much relies on the documentation due to safety issues. Generally, aircraft have to be produced exactly as required in drawings and other production documentation and deviation can lead to serious legal issues. The response of the Canadian manager then led to two follow-up issues. First, it led to a discussion of how production was taking place in Canada since the employees in Canada were faced with the same inadequate drawings and process planning sheets. The explanation for this, provided by the Canadian manager, was that within the Canadian company, these kinds of issues could be dealt with in an informal way. That is, operators at the shop floor deviated from the provided documentation but the managers were aware of this and due to the cost of documentation changes, it was acceptable. Further interviewing of Romanian employees who had received training in the Canadian factory confirmed this viewpoint. This then raised a subsequent issue, namely why the Romanian operators could not use similar approach. The explanation, again checked through multiple sources, was that in the case of the Romanian company, this was not acceptable since the Romanian company is a separate entity and has a legal responsibility to produce exactly according to the provided information otherwise, it is legally liable. The second follow-up issue was on the skill level of Romanian employees. Although the Romanian and Canadian managers indicated that the skill level of Romanian operators was comparable to the Canadian skill level this was investigated. In this instance, we found that, Romanian operators received both practical and theoretical tests at the beginning of the technology transfer to determine their skill level. These tests results, which were shared with us, confirmed that the Romanian operators had similar skill levels as Canadian operators. This description shows how data collection was directed by the constant comparison method and how emergent issues arose in the cases. It also shows how important it is for researchers who use this type of research study to keep an open mind.

If interview data, together with data from the documentation and/or observations confirmed each other, it was deemed credible, i.e. we would conclude that we uncovered the true meaning. Otherwise, continued interviews, observations and document analysis were applied to determine what really happened or to get to deeper issues. We did not rely on any one specific data format, even if data represented in that format appeared to be consistent. For example, in the first case, the progress of the technology transfer showed huge delays. The analysis of progress reports and written communication between the two companies indicated that the company in the United Kingdom was unable to deliver materials and parts on time because the Romanian company was responsible for their shipment from the United Kingdom but this company did not have enough transportation resources. From the analysis, it appeared that delays were caused by the unavailability of parts and materials. However, during the interviews the true meaning of the events became clear. The delayed materials and parts did not influence the production process, rather, because the production was already delayed, these materials were not yet required and since the Romanian company had to pay upon receipt of the goods, it effectively blocked the receipt of these goods by not providing transportation.

For each case study, aside from using multiple sources, we also used member checks to verify that our interpretations were correct. Member checks involve feeding back information to informants (Miles & Huberman, 1994: 275). An issue with this type of feedback is that it may influence the informants in future data collection. We therefore provided case study reports to only a few Romanian informants at the end of the first and second case study. At the end of the third case, case study reports were shared with more people and we gave a presentation to a larger audience to solicit feedback. At the end of the fourth case study we also provided case study reports and we gave a presentation to a larger audience to solicit feedback.

Overall, in the four case studies approximately 315 interviews were held with 45 employees from the Romanian company and the foreign companies involved in the technology transfer.

Furthermore, observations were continuous during a total of nine months of field research and thousands of pages of documents were analyzed.

Case selection. The selection of cases was, similarly to in-case data collection, based on developing insights during the field study. Case selection was therefore not determined in advance but emerged during the field study in accordance with the theoretical sampling strategy in grounded theory (Glaser, 1978: 36-45; Glaser, 1992: 101-107; Glaser and Strauss, 1967: 45-77). The first case study concerned the transfer of an aircraft production line from the United Kingdom to Romania. This technology was at the end of its technology life cycle in the United Kingdom. During the case collection and analysis, it was found that managing such a technology transfer was rather complex. In fact, the data analysis was also suffering from the size and complexity of the transfer because it made it hard to separate issues and get a more in-depth understanding of emerging concepts. Therefore, a choice was made for a second case with a much smaller technology. The second case concerned the transfer of an established aircraft cockpit production line from Canada to Romania. One of the main issues that emerged during this case study was that some delays in the technology transfer process were caused by factors that were outside of the control of the Romanian and Canadian companies, for example corruption at the customs. However, one issue that was inside the control of the companies was the adequacy of the product and production documentation. The case analysis showed that the documentation was inadequate which caused delays due to the need to clarify issues and change the documentation. The idea of inadequate information connected with the age of a production technology was compared with the first case where this was also found. Based on this finding a third case was selected with a much newer production technology to compare whether this concept was also relevant in such an instance. The third case study focused on the transfer of an aircraft tail production line from the United Kingdom to Romania. This aircraft was at the very early stages of production. During this third case study, it was found that new technologies also have information adequacy problems, but that they were of a different nature. In particular, the documentation was unstable due to design changes as a result of testing. Furthermore, the third case study findings confirmed the occurrence of several factors that caused delays which were related to the overall Romanian environment. Therefore a fourth case study was chosen where technology transfer occurred between two industrialized nations to compare and contrast with the earlier three case studies. This fourth case study concerned the transfer of an established aircraft skin panel production line from Germany to the Netherlands. During this fourth case study it was discovered that industrialized nations have an overall environment that is more conducive to business and hence the environment factors that were noted in the first three case studies were not as obstructive. However, it was also found that documentation inadequacies had a much bigger effect because of interpretation issues whereas in the other cases the freedom of interpretation of production information was much more limited because the Canadian and United Kingdom companies provided training, something that was deemed unnecessary in the last case due to the expertise level of both companies. Furthermore, the problem with the adequacy of the documentation was compounded because the Dutch company used a different production philosophy and therefore, the documentation needed to be changed (and accepted by the German company). This problem also did not occur in the earlier cases since the Romanian company was required to produce exactly according to the provided documentation. Table 1 provides an overview of some of the case study characteristics.

Case	Technology	Age	Size	Source	Destination
One	Aircraft	10 years	96,000 drawings 368,000 direct man-hours	United Kingdom (A)	Romania (A)
Two	Cockpit	5 years	130 drawings 1147 direct man-hours	Canda	Romania (A)
Three	Tail	1 year	125 drawings 847 direct man-hours	United Kingdom (B)	Romania (A)
Four	Skin section	7 years	55 drawings 100 direct man-hours	Germany	Netherlands

Table 1: Case characteristics

Analysis

Data collection and analysis are simultaneous activities in grounded theory research. The constant comparison analysis leads to emerging issues which drives the data collection. Nevertheless, we chose to discuss data analysis separately to provide more information on the processes used.

One of the main activities in this type of research is to develop categories (Glaser, 1992: 45). A category gets developed (by constant comparisons) in terms of its properties, in terms of its relationship to other categories and primarily to the main concept, in this case technology transfer. During our analysis we continuously focused on these issues and based on the continuous analysis developed a case study report or storyline for each case study. The purpose of the case study reports was to describe the technology transfer process in terms of the developed concepts or categories and how these concepts were related to each other. It also dealt with the properties of concepts. For example, the concept of technology was one of the most important concepts since that is what is transferred. During the continued data collection and analysis, we kept 'molding' this concept in terms of its properties and the linkage of these properties with the process of technology transfer. In the cases, it was determined that the size of a production technology can have an important influence on the technology transfer process in particular it influences the time required for the transfer and it may add complexity in scheduling. We therefore collected data and performed analysis to determine the 'size' of a technology. This is not always a straightforward process. Glaser and Strauss (1967: 107) note that "After coding a category perhaps three or four times, the analyst will find conflicts in the emphasis of his thinking. He will be musing over theoretical notions and, at the same time, trying to concentrate on his study of the next incident, to determine the alternate ways by which it should be coded and compared." We encountered similar issues and as a result sometimes had to revisit our earlier determined categories. In the instance of the category of technology, we eventually concluded that a technology has characteristics such as its size and its age. The size is determined by the amount of documentation, the amount of machinery, and the amount of people involved. Each of these properties was specified in more detail. This technology 'definition' is by no means perfect but it is a start in determining hypothesis about what is being transferred in a technology transfer process.

After the completion of the fourth case study a case comparison report was written in which all of the generated categories were compared across cases. This was insightful because some categories were not identified in earlier case studies but appeared in later case studies. This didn't mean that these categories or concepts did not exist in the earlier data; it meant that their influence on the process of technology transfer in those instances was limited and/or that we did not pursue them as emerging due their limited impact on the process of technology transfer. For example, as mentioned above, in the fourth case study we found out that there were problems with the documentation because the Dutch company followed different production procedures than the German company. We did not find this type of documentation problem in the earlier cases but this was due to the fact that the Romanian company followed the exact same procedures as the Canadian and United Kingdom companies in those instances. Therefore, we were able to add extra insight into the three Romanian cases.

At this phase in the study we used techniques that are provided by Miles and Huberman (1994) to develop coherent descriptions of what and how things happened in the four cases. In particular we used causal networks (Miles and Huberman, 1994: 228) to display the main variables and their effect on the occurrence of delays in the technology transfer process. The causal networks were accompanied by a text storyline, explaining the events in the particular case. The causal network diagrams included all of the important variables, numbered similarly for each case, and with an estimated 'value'. An example of such causal network is provided in figure 1, which is based on the second case study. In this figure, estimates for system states were based on field study judgments. Estimates for delays in activities were based on the total time span of the process phase and the importance for being on time. Thus, a 10% deviation (approximately four weeks) was considered high. This led to the following values: Low for less than one week delay, low-med for delays between one and two weeks, med for two to three week delays, med-high for delays of three to four weeks, and high for delays of more than four weeks. A negative value was assigned if the activity was faster than planned. Figure 1 shows how different factors contribute to delays in the delivery on the first cockpit to Canada. In this case, there was no delay (number 73) although the assembly activities (number 70 and 71) were delayed but this delay was made up by fast shipping (number 24 and 72). The middle part in the figure (factors 36, 39, 42, 46, 50, 53, 56, 59, 62, and 65) represents the scheduled activities in the technology transfer. That is, these are the ten categories or concepts that the companies used in their schedule that make up the technology transfer process. The combination of a concept from the schedule with additional factors such as 37 and 38 shows allow determining where delays occur. For example, in this particular case, the activity "layout and furniture" started on time (factor 36) but the implementation of this activity took much longer than planned (factor 37), therefore, this activity was finished much later than planned (factor 38). The figure shows that a lower productivity level at the Romanian company (factor 35) caused the long implementation (factor 37). The concept of productivity (factor 35) depends on a number of other factors including for example the local working conditions (factor 10) and the attitude towards time (factor 13). Towards the top on the left hand side is the concept of accuracy of information (factor 29). This concept has two distinct sub-concepts: reliability (27) which is independent of the technology receiving company and suitability (28) which is dependent on the technology receiving company. Reliability is determined by how stable the technology is, e.g. in this case, the technology was old and did not change anymore, therefore the stability was high (6), and by how up-to-date the information is, e.g. in this case, the Canadian operators deviated from the drawings, therefore the up-to-dateness was low (7). The concept of suitability was not apparent during this case study but showed up in case study four. During the cross-case analysis, we therefore went back to earlier cases and filled in the missing parts that were not apparent in earlier cases. Suitability did not play a role in this case because the information was suitable for the Romanian company. This explains why this concept only emerged in a subsequent case. Suitability is determined by how ambiguous (8) the information is presented, e.g. in this case, the information showed a number of instances where Romanian operators could (and did) interpret the information differently than the Canadian company intended. This also depends on the knowledge level of employees (28). The second concept was the applicability of the information (7) which was high in this instance because the Romanian company followed the exact same production methods and philosophy (9) as the Canadian company. Figure 1 shows that we found 22 input factors that influenced, in some cases through intervening variables, the final outcome of the project (factor 73).

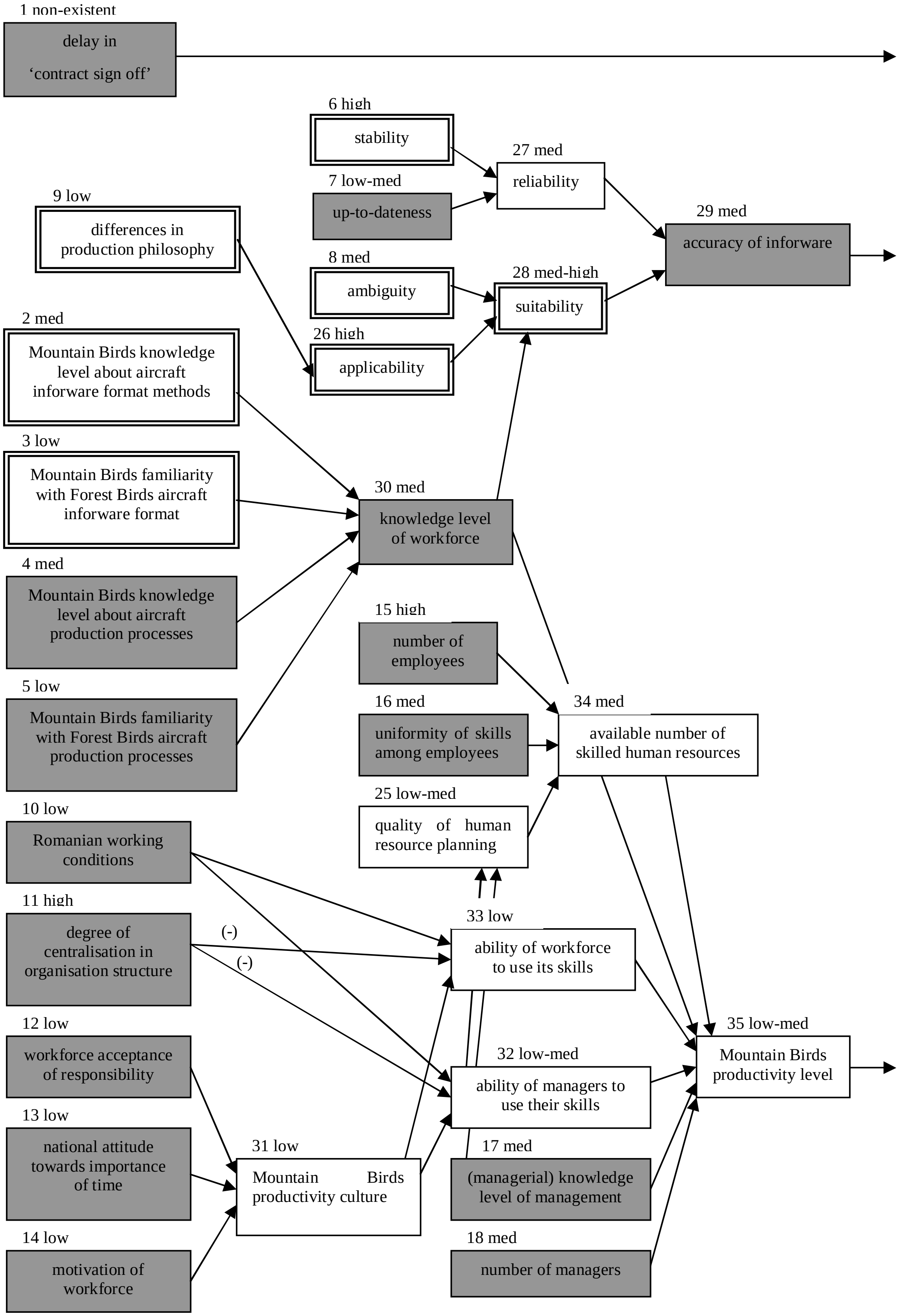
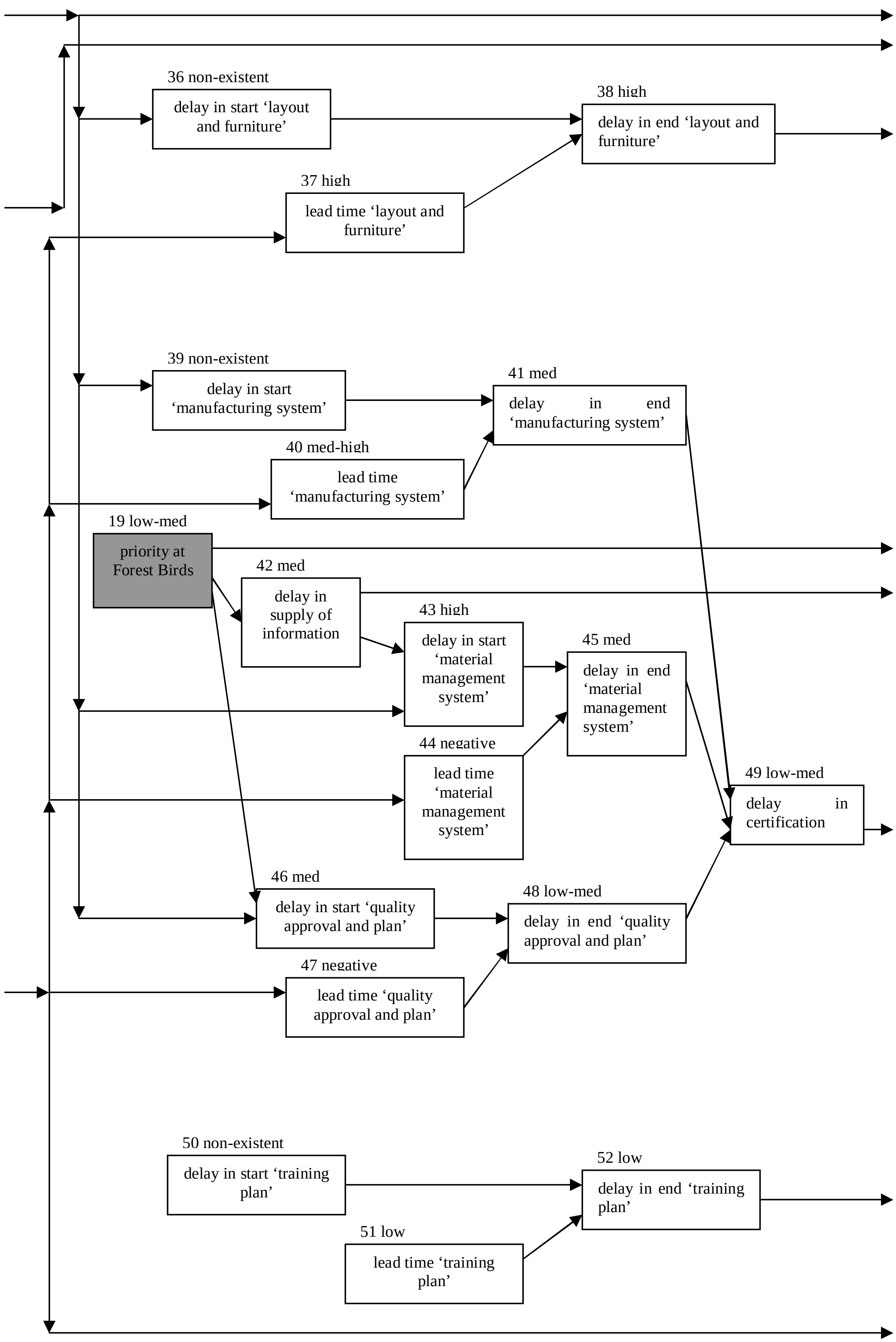
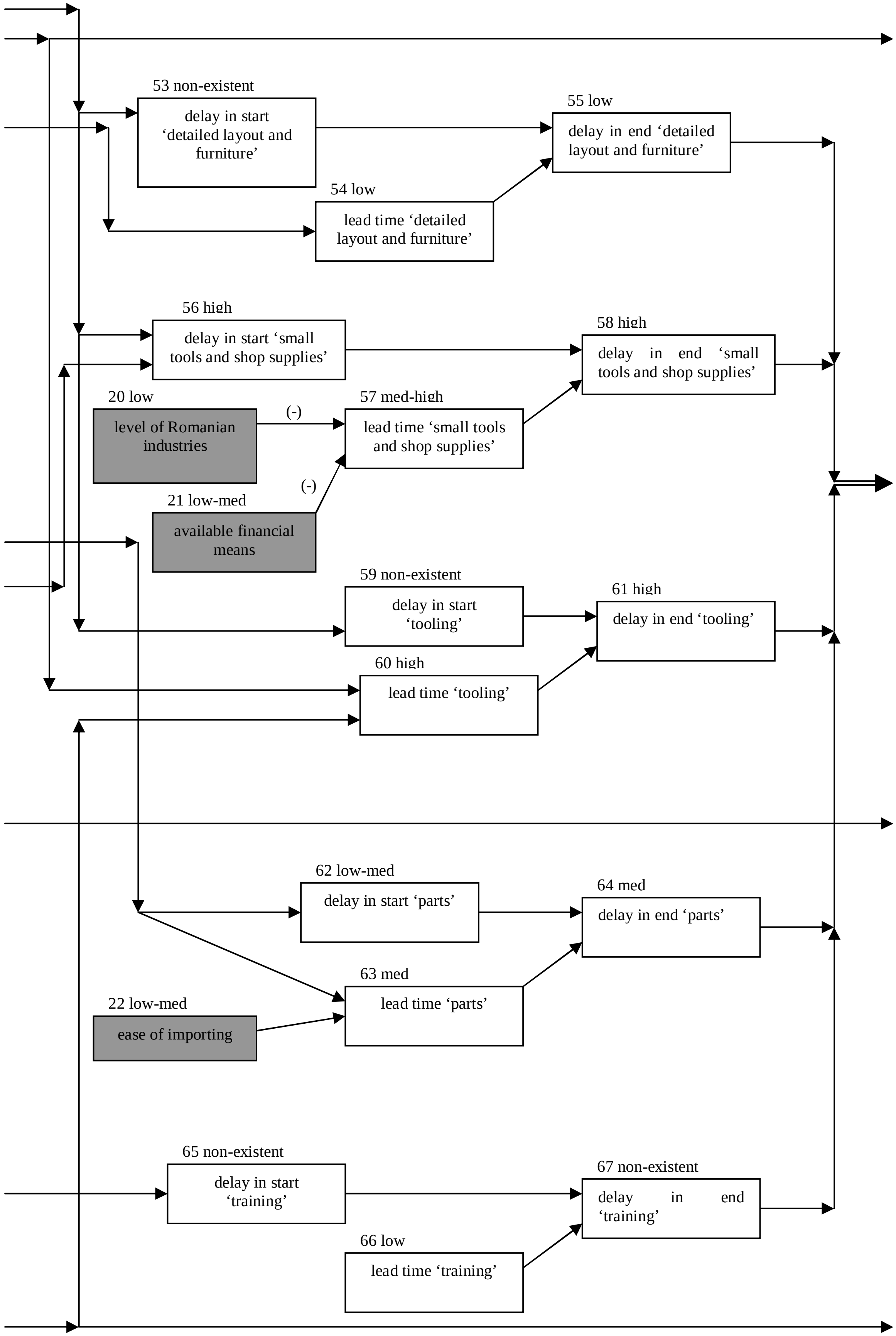
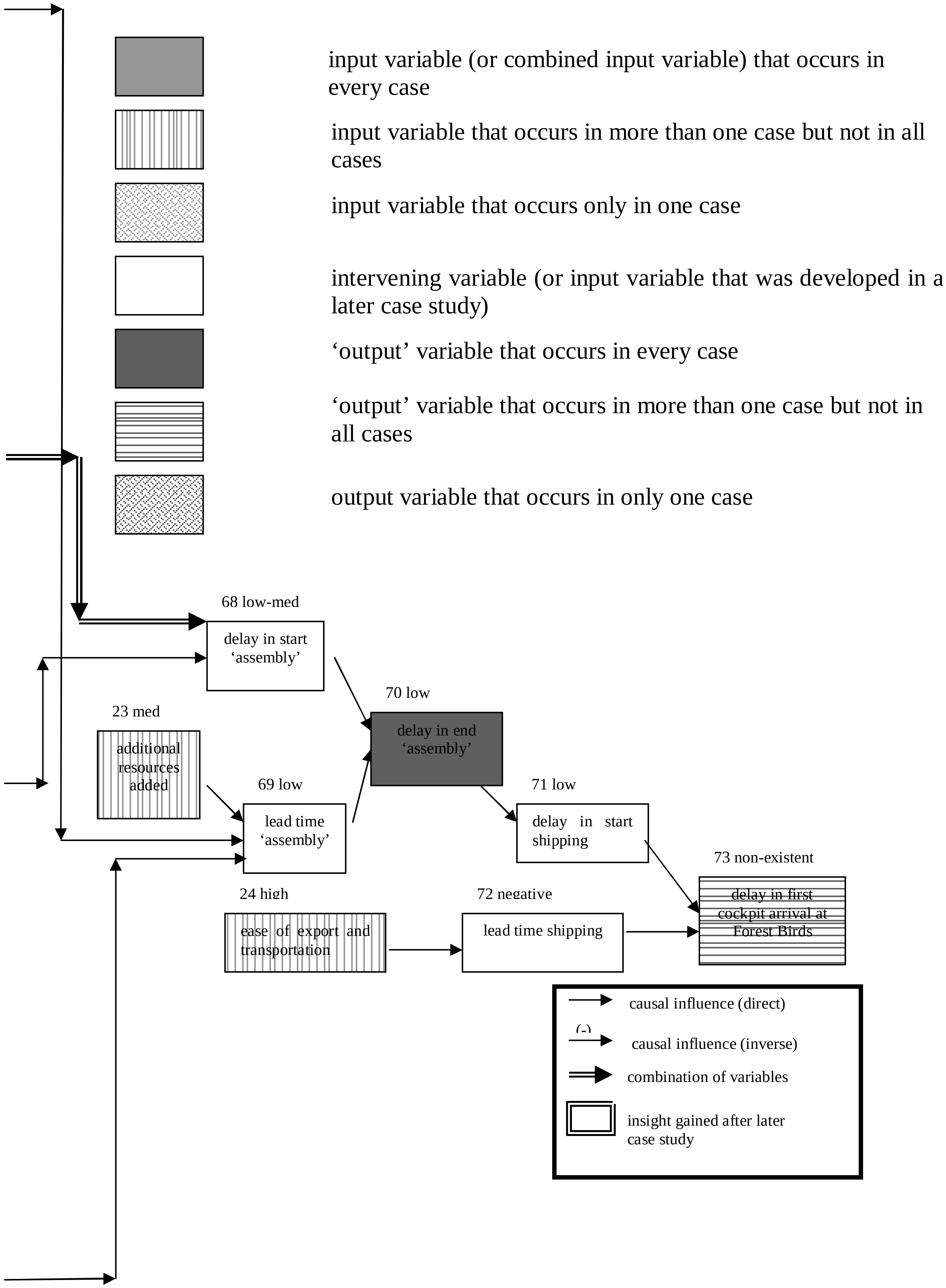


Figure 1: Causal network installation phase Swan case


36 non-existent
delay in start 'layout and furniture'
38 high
delay in end 'layout and furniture'
37 high
lead time 'layout and furniture'
39 non-existent
delay in start 'manufacturing system'
41 med
delay in end 'manufacturing system'
40 med-high
lead time 'manufacturing system'
19 low-med
priority at Forest Birds
42 med
delay in supply of information
43 high
delay in start 'material management system'
45 med
delay in end 'material management system'
44 negative
lead time 'material management system'
49 low-med
delay in certification
46 med
delay in start 'quality approval and plan'
48 low-med
delay in end 'quality approval and plan'
47 negative
lead time 'quality approval and plan'
50 non-existent
delay in start 'training plan'
52 low
delay in end 'training plan'
51 low
lead time 'training plan'



53 non-existent
delay in start 'detailed layout and furniture'
55 low
delay in end 'detailed layout and furniture'
54 low
lead time 'detailed layout and furniture'
56 high
delay in start 'small tools and shop supplies'
58 high
delay in end 'small tools and shop supplies'
20 low
level of Romanian industries
(-)
57 med-high
lead time 'small tools and shop supplies'
(-)
21 low-med
available financial means
59 non-existent
delay in start 'tooling'
61 high
delay in end 'tooling'
60 high
lead time 'tooling'
62 low-med
delay in start 'parts'
64 med
delay in end 'parts'
63 med
lead time 'parts'
22 low-med
ease of importing
65 non-existent
delay in start 'training'
67 non-existent
delay in end 'training'
66 low
lead time 'training'


input variable (or combined input variable) that occurs in every case
input variable that occurs in more than one case but not in all cases
input variable that occurs only in one case
intervening variable (or input variable that was developed in a later case study)
‘output’ variable that occurs in every case
‘output’ variable that occurs in more than one case but not in all cases
output variable that occurs in only one case
68 low-med
delay in start ‘assembly’
70 low
delay in end ‘assembly’
23 med
additional resources added
69 low
lead time ‘assembly’
71 low
delay in start shipping
73 non-existent
delay in first cockpit arrival at Forest Birds
24 high
ease of export and transportation
72 negative
lead time shipping
causal influence (direct)
(-)
causal influence (inverse)
combination of variables
insight gained after later case study

FINDINGS

Our study was focused on uncovering the process of international production technology transfer. Although there were three different types of technology transfer, the process of technology transfer was found in the four case studies to be very similar. In other words, a general set of characteristics was found that could describe and explain the four different case studies regardless of the differences that were actually found within the case studies.

The general characteristics of the technology transfer process included similar phases and factors. The case studies showed that the process of technology transfer consists of three phases: a preparation phase, an installation phase, and a utilization phase. These three phases are influenced by three groups of factors: technological factors, organizational factors, and environmental factors. This leads to a model for the technology transfer process as given in figure 2.

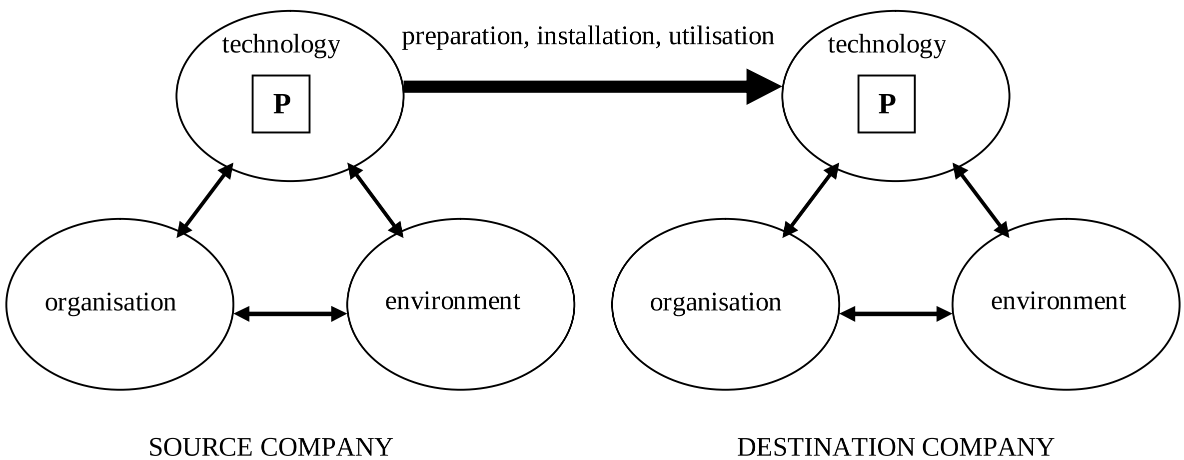


Figure 2: The Technology Transfer Balance

The model is called the Technology Transfer Balance to emphasize that for an efficient transfer, the two individual companies need to be balanced with each other. Technology transfer can be compared to an organ transplant. If the two bodies do not show enough similarities, the transplant will be highly problematic. During our research, we came across several new insights that are important in technology transfer.

- The production technology influences the process of transfer due to some of its characteristics, notably age and size. The age of a technology can be measured from the moment that a product was first produced. Age influences the reliability of the production information. The size of a technology can be measured by looking at three components of technology: humanware, inforware and technoware. The combination of these three components is used to transform inputs into an output (aircraft (parts)). For aircraft production, this combination of components has to be approved by either an aviation authority or a supervising company. The humanware component relates to the direct labor involved in production. This can be determined by the number of employees and their skill level. Whether employees are able to efficiently use their skills is influenced by other factors such as working conditions. The inforware component related to the production documentation. This can be measured by the number of drawings, process planning sheets, process specifications, and the bill of material. An important property of inforware is the accurateness of the documentation. This depends on it reliability, which is independent of the receiving company, and suitability, which is dependent on the receiving company. The technoware component related to the machinery et cetera. This can be measured by the factory floor area, and the numbers of production equipment (general and product specific (for example jigs)). The input to the production process is a combination of product specific detail parts and/or (sub)-assemblies, materials, fasteners, and non-consumables (for example tape). The output is an aircraft or aircraft part with dimension characteristics, performance characteristics, functional characteristics, and demand characteristics. The production process is guided by management which is determined by the number of managers and their skills.

- The horizontal international transfer of aircraft (parts) production technology is the transfer of all or some of the components of aircraft (parts) production technology from a source company (SC) in one country to a destination company (DC) in a different country.
- There are two main types of horizontal international transfer of aircraft (parts) production technology: technology selling and technology sharing. Technology selling is a process where the DC buys the technology. Technology sharing is a process whereby the SC freely provides the technology to the DC but whereby the DC does not gain ownership of the technology. Situations where a SC has produced products for some time and then decides to outsource the production to a DC are situations of sharing. The distinction of selling and sharing influences the legal liability and flow of money.
- The horizontal international transfer of aircraft (parts) production technology is a process that has three sequential phases: preparation, installation and utilization. During the preparation phase the companies are involved in a dialogue where they estimate and decide on the type of technology that will be transferred, how to schedule it, the monies involved et cetera. When this phase is completed, the next phase starts. During the installation phase activities are undertaken to set up a technology at the DC. Part, or all, of the technology at the DC will be an exact copy of the technology at the SC. The installation phase ends with the successful production of the first unit of the product. Then follows the utilization phase. The production technology is now fully installed at the DC and continuous production takes place.
- There are many factors that influence the outcome of the technology transfer process, in particular, the timing of this process. These factors can be grouped in three categories: technological, organizational and environmental factors. The technological factors are the size and age of the technology. The organizational factors are the capacity (how much), the capability (how complex) and the efficiency of the organization. The environmental factors include the national environment, the national business environment and the (international) industry environment. Factors in the national environment are: political stability, international political position, type of economy, level of industrialization (infrastructure et cetera), attitude towards time, and working conditions. The national business environment is determined by the level of related and supporting industries. The (international) industry environment is determined by factors such as: the strategic position of the company, the level of concentration in the industry, mandatory industry requirements (such as certification procedures) and market demand.
- The preparation phase has four activities: exploration of opportunities, developing a proposal, reaching agreement, and developing a project plan. The order of the activities in the

preparation phase depends on the type of technology transfer. If there are several potential DCs, then a formal proposal will be made. If the project plan involves elements that are specified in the contract, for example delivery of parts on specific dates coupled with payment, then the project plan and the contract development will occur simultaneously. If the management of the DC is considered highly competent by the SC, then the DC will develop the detailed project plan after the agreement is reached. Otherwise, the SC will develop the project plan before the agreement is reached. The technological factors are important in the preparation phase to determine what will be transferred and how the transfer will be implemented. The organizational factors and the environmental factors are important in the preparation phase to forecast their potential impact. In addition, some of the organizational factors and the environmental factors can be the cause (motivation) for the technology transfer to take place.

- The installation phase contains seven groups of activities related to transferring the production technology components: transferring inforware from the SC to the DC, bringing humanware up to the required level at the DC, translating and processing the inforware at the DC, bringing the technoware up to the required level at the DC, assuring production inputs at the DC, producing and inspecting the first article (batch) at the DC, and delivering the first product (batch) to the customer. The most important factors in the installation phase are: the efficiency of the DC organization, the appropriateness of the inforware (and related to this, the priority given by the SC to the project and the sophistication and reliability of the local communication infrastructure in the destination country), the sophistication and reliability of related industries in the destination country, and the approval procedures in the aircraft industry.
- The utilization phase has three activities: managing the production by the DC, dealing with technical queries by both companies, and managing the production network by the SC. These activities occur simultaneously. The most important factors in the utilization phase are: the efficiency of the DC, the appropriateness of the inforware and, related to this, the priority of the SC and the local communication infrastructure in the destination country, the level of related industries in the destination country, any decision to change from dual to single source by the SC, and the market demand for the product.

CONCLUSIONS

Our research was conducted to gain insight into the process of international technology transfer particularly from the perspective of the receiving company. We carried out four case studies in the aircraft industry. These covered two different types of horizontal technology transfers, i.e. technology sharing and technology selling, and were based in two destination companies. We found that the international technology transfer process is characterized by three phases. First, preparation, which takes place before the actual transfer. Second, installation, which can be seen as the transfer of the production line. This phase ends when the first product is produced. Third, utilization, which covers continued production. The activities in the three phases are influenced by three groups of factors: technological, organizational and environmental.

Technological factors play a dominant role in the preparation phase while organizational and environmental factors have to be assessed to determine their potential impact. In our four cases we found that the choice of technology, a frequently discussed topic in the literature, was in practice limited during this phase. In the case of a technology sale, there are not many options in the aircraft industry. In the case of sharing, it depended on production capabilities of the receiving company. Our research furthermore showed that, although industrially developing countries are often interested in technology transfer for purposes of for technological development (another frequently discussed topic in the literature), technology transfer does not necessarily lead to a substantial increase in technological capabilities. In cases of technology sharing, technologies are only shared, if the receiving companies already have existing capabilities in place.

The installation phase, dealing with the transfer of the individual production technology components, is highly influenced by the amount of technology that is transferred and by the accuracy of the transferred information. Furthermore, the efficiency of the installation is impacted by differences between the source and destination companies. The more differences in these organizations, for example their structure, and their environment, for example the level of local supporting industry, the more likely that problems will occur leading to delays. As an analogy, international technology transfer can be compared to an organ transplant, the fewer similarities between the donor and host exist the more difficult the transfer. Companies that want to engage in technology transfer should therefore carefully assess their differences.

Only two of our cases reached the utilization stage of continued production. The activities in this phase continue to be influenced by organizational and environmental differences as well as by the level of priority that the source company gives to the technology transfer project. In this phase, although the destination company has proven that it can produce the product, continued support is required but it may not be a priority for the source company.

In our study, we did not find activities such as packaging of the technology and getting ready to transfer a technology. Instead, we found activities such as receiving and translating information, receiving parts, and inspection of parts. These insights are complementary to earlier literature contributions from the sending company perspective and together, they provide a comprehensive description of international technology transfer.

REFERENCES

Agmon, T. and Von Glinow, M. A. (Eds.). 1991. ***Technology transfer in international business,*** New York: Oxford University Press.

Al-Ali, S. 1995. Developing countries and technology transfer. ***International Journal of Technology Management***, 10 (7/8): 704-713.

Al-Ghailani, H. H. and Moor, W. C. 1995. Technology transfer to developing countries. ***International Journal of Technology Management***, 10 (7/8): 687-703.

Al-Obaidi, Z. 1993. ***International technology transfer mode selection.*** Unpublished licentiate thesis, Helsinki School of Economics and Business Administration, Helsinki, Finland.

Amsalem, M. A. 1983. ***Technology choice in developing countries, The textile and pulp and paper industries,*** Cambridge, MA: The MIT press.

Baranson, J. 1970. Technology transfer through the international firm. ***American Economic Review***, 60: 435-440.

Bar-Zakay, S. N. 1972. Technology transfer model. ***Industrial R&D News,*** 6(3): 2-11.

Behrens, W. and Hawranek, P. M. 1991. ***Manual for the preparation of industrial feasibility studies.*** Vienna, Austria: United Nations Industrial Development Organization.

Behrman, J. N. and Wallender, H. W. (1976). ***Transfers of manufacturing technology within multinational enterprises.*** Cambridge, MA: Ballinger Publishing Company.

Bruun, P. and Mefford, R. N. 1996. A framework for selecting and introducing appropriate production technology in developing countries. ***International Journal of Production Economics,*** 46-47: 197-209.

Chantramonklasri, N. 1990. The development of technological and managerial capability in the developing countries. In M. Chatterji (Ed.), ***Technology transfer in the developing countries:*** 36-50. Houndsmills: The Macmillan Press.

Chen, M. 1996. ***Managing international technology transfer,*** London: International Thomson Business Press.

Clifford, M. L. 1997. How you can win in China, The obstacles are huge but surmountable. ***Business Week***, May 26: 40-44.

Cooper, C. 1973. ***Science, technology and development, the political economy of technical advance in underdeveloped countries***. London: Frank Cass

Dahlman, C. J., Ross-Larson, B. and Westphal, L. E. 1985. ***Managing technological development, Lessons from the Newly Industrializing Countries***. Working papers no. 717, World Bank, Washington D.C.

Dahlman, C. J. and Westphal, L. E. 1981. The meaning of technology mastery in relation to transfer of technology. ***The Annals of the American Academy of Political and Social Science***, 458: 12-26.

Dam, C. van & Deitz, R. M. H. 1995. Uitdagingen voor het Nederlandse bedrijfsleven. ***Bedrijfskunde***, 67(4): 62-72.

Djeflat, A. 1988. The management of technology transfer: Views and experiences of developing countries. ***International Journal of Technology Management***, 3(1/2): 149-165.

Erickson, T. J. Magee, J. F. Roussel, P. A. and Saad, K. N. 1990. Managing technology as a business strategy. ***Sloan Management Review***. Spring: 73-78.

Ferdows, K. 1989. Mapping international factory networks. In K. Ferdows (Ed.), ***Managing international manufacturing***: 3-21. Amsterdam: North-Holland.

Ford, D. & Ryan, C. 1981. Taking technology to market. ***Harvard Business Review***. March-April: 117-126.

Glaser, B. 1978. ***Theoretical sensitivity***. Mill Valley, CA: Sociology Press.

Glaser, B. 1992. ***Basics of grounded theory analysis: emergence vs. forcing***. Mill Valley, CA: Sociology Press.

Glaser, B. & Strauss, A. 1967. ***The discovery of grounded theory***. Chicago: Aldine.

Godkin, L. 1988. Problems and practicalities of technology transfer: a survey of the literature. ***International Journal of Technology Management***, 3(5): 587-603.

Gorman, M. E. 2002. Types of knowledge and their roles in technology transfer. ***Journal of Technology Transfer,*** 27: 219-231.

Grant, E. B. 1997. ***The international transfer of manufacturing: linking content and process***. Unpublished doctoral dissertation, University of Cambridge, Cambridge, England.

Grant, E. B. and Gregory, M. J. 1997a. Adapting manufacturing processes for international technology transfer. ***International Journal of Operations and Production Management,*** 17(10): 994-1005.

Grant, E. B. and Gregory, M. J. 1997b. Tacit knowledge, the life cycle and international manufacturing transfer. ***Technology Analysis and Strategic Management***, 9(2): 149-161.

Guba, E. G. & Lincoln, Y. S. 1994. Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), ***Handbook of qualitative research***: 105-117. Thousand Oaks, CA: Sage Publications.

Heston, A. W. and Pack, H. (Eds.). 1981. ***Technology transfer: new issues, new analysis***. Beverly Hills, CA: Sage Publications.

Hill, T. 1985. ***Manufacturing strategy, The strategic management of the manufacturing function***. Houndmills: Macmillan.

Hirsch, S. 1976. An international trade and investment theory of the firm. ***Oxford Economic Papers***, 28: 258-270.

Howells, J. 1996. Tacit knowledge, innovation and technology transfer. ***Technology Analysis and Strategic Management***, 8(2): 91-106.

Hussain, S. 1998. Technology transfer models across cultures: Brunei – Japan joint ventures. ***International Journal of Social Economics***, 25 (6/7): 1189-1198.

Hutjes, J. M. and van Buuren, J. A. 1992. ***De gevalsstudie: strategie van kwalitatief onderzoek***. Meppel, The Netherlands: Boom.

Hymer, S. H. 1976. ***The international operations of national firms: A study of direct foreign investment.*** Cambridge, MA: The MIT Press.

Kaplinsky, R. 1990. Technology transfer, adaptation and generation: A framework for evaluation. In M. Chatterji (Ed.), ***Technology transfer in the developing countries:*** 36-50. Houndsmills: The Macmillan Press.

Kedia, B. L. and Bhagat, R. S. 1988. Cultural constraints on transfer of technology across nations: Implications for research in international and comparative management. ***Academy of Management Review***, 13(4): 559-571.

Kumar, B. N. 1995. Partner selection criteria and success of technology transfer: A model based on learning theory applied to the case of Indo-German technical collaborations. ***Management International Review***, 35(1): 65-78.

Laseur, W. J. J. 1991. ***Managing technology transfer***. Zuthpen, The Netherlands: Thieme.

Legg, C. L. 1991. ***Technology transfer: assessing the conditions for collaboration between Chinese and European enterprises.*** Unpublished doctoral dissertation, University of Cambridge, Cambridge, England.

Lewis, P. 1998a. Trunkliner program scrapped. ***Flight International***, 29 July - 4 August: 4.

Lewis, P. 1998b. Asia's economic crisis has forced a new reality on to its once-ambitious aerospace industry. ***Flight International***. 2-8 September: 85-87.

Madu, C. N. 1989. Transferring technology to developing countries – critical factors for success. ***Long Range Planning***, 22(4): 115-124.

Mann, J. 1989. ***Beijing Jeep, The short, unhappy romance of American business in China***. New York: Simon and Schuster.

Mansfield, E. 1975. East-West technological transfer issues and problems, International technology transfer: forms, resource requirements, and policies. ***American Economic Review***, 65(2): 372-376.

Mansfield, E., Romeo, A., Schwartz, M., Teece, D., Wagner, S. and Brach, P. (Eds.) 1982. ***Technology transfer, productivity, and economic policy***. New York: W.W. Norton & Company.

Marcelle, G. M. 2003. Reconsidering technology transfer. ***International Journal of Technology Transfer and Commercialization***, 2(3): 227-248.

Marcotti, C. and Niosi, J. 2000. Technology transfer to China, The issues of knowledge and learning. ***Journal of Technology Transfer,*** 25: 43-57.

Meredith, J. 1998. Building operations management theory through case and field research. ***Journal of Operations Management***, 16: 441-454.

Miles, D. 1995. ***Constructive change: Managing international technology transfer.*** Geneva: International Labour Office.

Miles, M. B. and Huberman, A. M. 1994. ***Qualitative data analysis, An expanded sourcebook***. Thousand Oaks, NJ: Sage Publications.

Mital, A., Girdhar, A. and Mital, A. 2002. Issues in transferring technologies to maquiladoras. ***International Journal of Technology Transfer and Commercialization***, 1(4): 405-423.

Morone, J. 1989. Strategic use of technology. ***California Management Review***. Summer: 91-110.

Moustafa, M. E. 1990. ***Management of technology transfer: planning and controlling the implementation process in developing countries.*** Geneva: International Labour Office.

Moxon, J. & Lewis, P. 1998. Airbus industries and AVIC abandon AE31X. ***Flight International***, 8-14 July: 6.

Perlmutter, H. V. and Sagafi-nejad, T. 1981. ***International technology transfer, Guidelines, codes and a muffled quadrilogue.*** New York: Pergamon Press.

Popper, E. T. and Buskirk, B.D. 1992. Technology life cycles in industrial markets. ***Industrial Marketing Management***. 22: 23-31.

Porter, M. E. 1986. Competition in global industries: A conceptual framework. In M. E. Porter (Ed.) 1986. ***Competition in global industries***. Boston: Harvard Business School Press: 15-60.

Porter, M. E. 1990. ***The competitive advantage of nations***. New York: The Free Press.

Ramanathan, K. 1994. The polytrophic components of manufacturing technology. ***Technological Forecasting and Social Change***, 46: 221-258.

Robinson, R. D. 1988. ***The international transfer of technology, Theory, issues, and practice***. Cambridge, MA: Ballinger Publishing Company.

Rosenberg, N. and Frischtak, C. (Eds.). 1985. ***International technology transfer: concepts, measures, and comparisons.*** New York: Praeger Publishers.

Sagafi-nejad, T., Moxon, R. W. and Perlmutter, H. V. (Eds.) 1981. ***Controlling international technology transfer, Issues, perspectives, and policy implications***. New York: Pergamon Press.

Samli, A. C. (Ed.). 1985. ***Technology transfer, Geographic, economic, cultural, and technical dimensions***, Westport, CT: Quorum Books.

Schwandt, T. O. 1994. Constructivist, interpretivist approaches to human inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), ***Handbook of qualitative research***: 105-117. Thousand Oaks, CA: Sage Publications.

Sharif, M. N. 1986. Measurement of technology for national development. ***Technological Forecasting and Social Change***, 29: 119-172.

Shi, Y. & Gregory, M. 1998. International manufacturing networks – to develop global competitive capabilities. ***Journal of Operations Management***, 16: 195-214.

Steenhuis, H. J. & de Boer, S. J. 2002. Differentiating between types of technology transfer: the technology building. ***International Journal of Technology Transfer and Commercialization***, 1(1/2): 187-200.

Stewart, F. 1979. ***International technology transfer, Issues and policy options***. Working paper no. 344, World Bank, Washington.

Stobaugh, R. and Wells, L. T. Jr. (Ed.). 1984. ***Technology crossing borders, The choice, transfer, and management of international technology flows***. Boston, MA: Harvard Business School Press, Boston, Massachusetts, 1984.

Technology Atlas Team 1987. Components of technology for resources transformation. ***Technological Forecasting and Social Change***, 32: 19-35.

Teece, D. J. 1976. ***The multinational corporation and the resource cost of international technology transfer***. Cambridge, MA: Ballinger Publishing Company.

Teece, D. J. 1981. The market for know-how and the efficient international transfer of technology. ***Annals American Academy of Political and Social Science***, 458: 81-96.

Tsang, E. W. K. 1994. Strategies for transferring technology to China. ***Long Range Planning***, 27(3): 98-107.

Tsang, E. W. K. 1997. Choice of international technology transfer mode: A resource-based view. ***Management International Review***, 37(2): 151-168.

UNCTAD 1978. ***Handbook on the acquisition of technology by developing countries***, New York: United Nations.

UNIDO. 1979. ***Guidelines for evaluation of transfer of technology agreements***, Development and transfer of technology series no. 12, United Nations, New York.

Vernon, R. and Wells, L. T. Jr. 1991. ***The economic environment of international business*** (5th ed.). Englewood Cliffs, NJ: Prentice Hall.

Wallender, H. W. III 1979. ***Technology transfer and management in the developing countries: Company cases and policy analysis in Brazil, Kenya, Korea, Peru and Tanzania.*** Cambridge, MA: Ballinger Publishing Company.

Woodward, J. 1965. ***Industrial organization: theory and practice***, London: Oxford University Press.

Yin, J. Z. 1992. Technological capabilities as determinants of the success of technology transfer projects. ***Technological Forecasting and Social Change***, 42: 17-29.

Yip, G. S. 1992. ***Total global strategy, Managing for worldwide competitive advantage***. Englewood Cliffs, NJ: Prentice Hall.