Copernicus Institute
for Sustainable Development and Innovation

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# GOVERNANCE AND INTELLIGENCE IN RESEARCH AND INNOVATION SYSTEMS

## Address

delivered upon the acceptance of the office of a Fraunhofer-ISI Professor
of 'Innovation Policy Analysis' at Utrecht University
on Monday, the 7th of October 2002.

by

**Prof. Dr. Stefan Kuhlmann**

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Contact: Utrecht University, Copernicus Institute for Sustainable Development and Innovation, Dept. of Innovation Studies, Heidelberglaan 8, PO Box 80125, 3508-TC Utrecht, Netherlands, pone ++31 (-30) - 2531625; www.nwi.uu.nl
Also: Fraunhofer Institute for Systems and Innovation Research (ISI), Breslauer Strasse 48, 76139 Karlsruhe, Germany, Phone ++49-721-6809-170/4; fax –260, stefan.kuhlmann@isi.fraunhofer.de; www.isi.fhg.de/ti/departm.htm

**Contents**

Rector magnificus, colleagues, family, friends, ladies and gentlemen,

## 1. Introduction: 'High-quality' Governance for Innovation?

In March 2000, at the Lisbon European Council, heads of state and government set the European Union (EU) the goal of becoming „the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" by 2010 (European Commission 2000). Two years later at the Barcelona European Council, which reviewed progress towards the Lisbon goal, they agreed that research and technological development (R&D) investment in the EU must be increased with the aim of approaching 3 % of the gross domestic product (GDP) by 2010, up from 1.9 % in 2000. Quite clearly, most of Europe's citizens, politicians and industrialists agree that science, research and technological innovation are important for the economic and social development of our societies. Stakeholders argue whether advanced technologies can simultaneously provide both economic growth and jobs, or are ethically acceptable. Nevertheless there is a strong belief that competitiveness based on technological innovation is a precondition of wealth, and that research is essential if we are to cope with increasing environmental, ecological or social problems and necessary transformations.

When I speak of research and innovation I do not use these terms as normative notions, neither do I mean superficial connotations of innovation like „change for change's sake" or „trendyness". In our work we apply the two terms as heuristic models helping to understand the emergence of new knowledge and artefacts: *research* and development by definition is „systematic, creative work that advances the state of our knowledge, whether in connection with man, culture or society and uses this knowledge to identify new potential applications" (Grupp, 1998, 11; OECD, 1992). Technological *innovations* by definition comprise implemented technologically new products and processes and significant technological improvements in products and processes. An innovation has been implemented if it has been introduced on the market or used within a production process. Innovations involve a series of scientific, technological, organisational, financial and commercial activities (cf. OECD, 1994, 31, building on Schumpeter, 1934).

Scientific research and technological innovation efforts in this sense meanwhile are spreading across all dimensions of human perception and existence, they reach out far into the outer space and – at the same time – are diving deeply into the nano-cosmos. There is a huge potential of improving the human living conditions, but there are obviously also numerous risks, technical, ethical and economic. Despite all assertions of unlimited „freedom of scientific research" researchers, business people and policymakers are setting priorities and are making decisions every day – thereby moving along evolving *trajectories*, excluding unexplored options and including known and unknown risks. The idea is widely accepted meanwhile that science – both beta and gamma sciences – and technology are *socially constructed* (Rip, 1978: „Wetenschap als Mensenwerk"). This is to say, research and innovation are not simply free and open-ended ventures into any direction – they are inevitably governed by individual and institutionalised interests and related powers. One may speak of the *governance of research and innovation systems.*

In his book „The Capacity to Govern" Yehezkel Dror stated: „The state of flux in which we are living, in combination with rapidly increasing human capacities to influence the future by deliberate actions, creates serious challenges for governing capacities on all levels, from the local to the global. Thus, humanity as a whole faces critical choices in respect to science and technology and their uses, including ... the future of global governance" (2001, 2ff). Consequently, Dror sees „the urgent need for a redesign of governance so as to ensure adequate capacities – with 'high-quality' governance being an essential minimum for coping with ongoing transformations".

Such thoughts frame, by and large, the general problem context in which we, my colleagues and I, are researching and teaching. Measured against Dror's far reaching demand, nevertheless, our ambition is rather modest and relatively concrete: The Department of Innovation Studies (DIS) at the Faculty of Geographical Sciences aims at contributing to the evolution of a sustainable society by developing knowledge of innovation processes and innovation systems, and by studying options and instruments of intervention, i.e. „high-quality" governance (in Dror's words[1]) in our thematic area. The guiding question of my work at DIS and also at my other affiliation, the Fraunhofer Institute for Systems and Innovation Research (ISI), – as well as of my lecture today – is:

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[1] See also Dror 2002.

*„To which extent and under which conditions can the institutional settings of research and innovation be deliberately shaped?"*[2]

I will treat this question in four steps: First I will introduce a *systemic view* of research and innovation, secondly I will discuss *rationales* of public research and innovation *policies*, then I will sketch an analytical frame helping to understand the *governance* of research and innovation systems, and finally I will present a concept of *„strategic intelligence"* for policymaking. Thereby, my statements are both drawing on own and colleagues' previous research and sketching paths for future investigation.

[2] The following text largely draws on previous publications of the author, in particular Kuhlmann (2001a; 2001b; 2002; 2003).

## 2. A Systemic View of Research and Innovation

### *Research and Innovation Systems*

„Research and innovation systems“ have been debated by social scientists (first of all by economists), since – with the increasing significance of international hi-tech markets – explanations for the differing degrees of competitiveness of economies, especially of their ability to innovate were sought. It was recognised that differing national[3], regional[4] or sectorial[5] patterns of technological and/or scientific specialisation and related „innovation cultures“, each rooted in historical origins, characteristic and unique industrial, scientific, state and politico-administrative institutions and inter-institutional networks, crucially affected the ability of academic and economic actors to produce and of policymakers to support successful innovations[6]. Comparative empirical studies demonstrated this even on the level of individual technological developments[7]. There is, however, no coherent theory yet on research and innovation systems. Rather, the related research is rooted in heterogeneous theoretical strands: evolutionary economics, in particular growth theory; microeconomics; innovation economics; sociology, in particular sociological system theory; action theories; neo-institutional approaches; sociology of organisation; sociology of science; political science, in particular policy analysis; neocorporatist analysis; international relations; science policy studies. For the time being I suggest to use the term „research and innovation system” just as a *helpful heuristic aide*.

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3 See in particular Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997. Lundvall/Maskell (1999) provide a reconstruction of the genesis of the expression „national innovation systems“.

4 E.g. Koschatzky et al., 2001; Meeus at al., 2001; Cooke et al., 2000; Howells, 1999; Braczyk et al., 1998.

5 E.g. Kitschelt, 1991; Malerba, 2002.

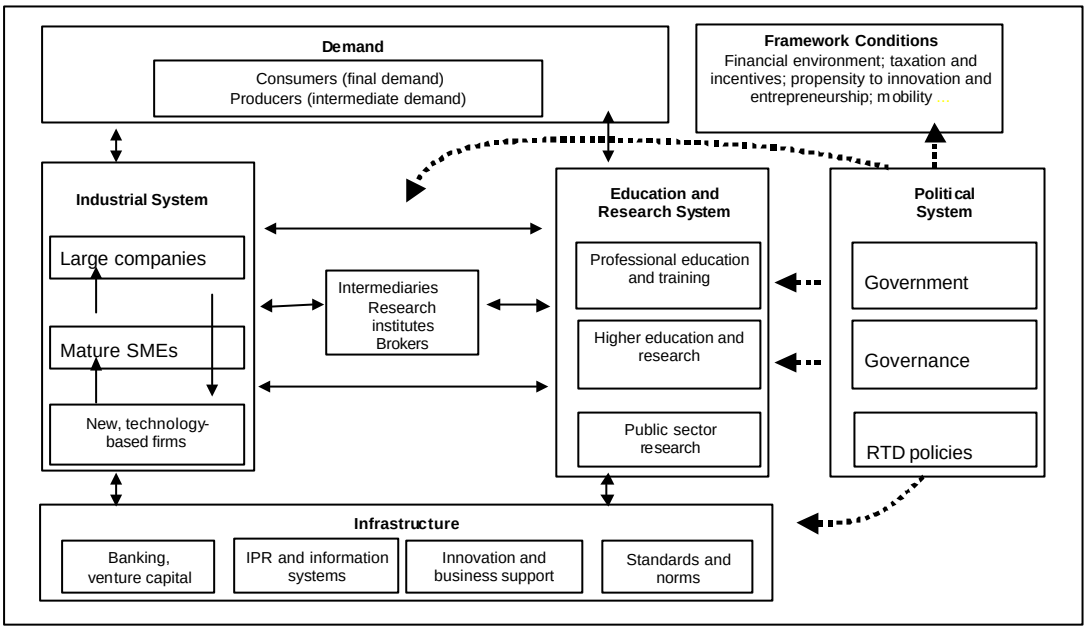
6 See Keck (1993) for the example of the German research and innovation system. Although not dealt with exhaustively, in the 90s many symptoms and functions of national innovation systems were analysed comparatively, such as national research systems (e.g. van der Meulen/Rip, 1994; Whitley, 1998) enterprise cultures (e.g. Whitley/Kristensen, 1996), as well as in general the national/regional various „embeddedness of institutions“ (Hollingsworth/Boyer, 1997).

7 So for example Jansen (1996) for the development of the high temperature supra-conductor in Germany and Great Britain as well as the example of the biotechnology industries of the USA and Germany.

The research and innovation system of a society encompasses, according to a meanwhile widely accepted understanding, the „biotope“ of all those institutions which are engaged in scientific research, the accumulation and diffusion of knowledge, which educate and train the working population, develop technology, produce innovative products and processes, and distribute them; to this belong the relevant regulative bodies (standards, norms, laws), as well as the state investments in appropriate infrastructures (see exhibit 1). Research and innovation systems extend over schools, universities, research institutions (education and science system), industrial enterprises (economic system), the politico-administrative and intermediary authorities (political system) as well as the formal and informal networks of the actors of these institutions (e.g. Schmoch, 2001), recently repeatedly also characterised as a ”Triple-Helix of university-industry-government relationship” (Etzkowitz/Leydesdorff, 2000). As a „hybrid system“ (Kuhlmann, 1999) it represents a section of the society which carries far over into other societal areas, e.g. through education, or through entrepreneurial innovation activities and their socio-economic effects: the innovation system has a decisive influence on the modernisation processes of a society (OECD, 1999a).

Each innovation system is different, just as one society is not the same as the others. Sustainable innovation systems develop their special competitive scientific, educational, technological profiles and strengths only slowly, in the course of decades, or even centuries. They are based on stable exchange relationships among the institutions of science and technology, industry and the political system. They make possible the formation of a characteristic, system-specific spectrum of different, unmistakable role definitions of the actors actively involved herein, come up with own negotiation arenas, and stabilise mutual expectations of behaviour. Finally, they bear particular, intermediary fora and bodies which facilitate the transactions of the actors of innovation systems.

*Exhibit 1: Research and innovation system and the reach of public policies*




Source: Technopolis 2000, modified and extended by S. Kuhlmann

### *Role of public policy*

Historically, the hybrid institutional infrastructures and networks of research and innovation systems did not come into existence spontaneously and without control: in the past 150 years, this area of society was formed by national state political interventions. The national political systems, themselves increasingly differentiated, developed innovation policy activities, in which they acted as catalysts, promoters and regulators of the innovation bodies which were emerging in many places: the establishment and growing economic significance of e.g. the colleges of engineering and the technical universities in France, Germany or in the USA document this clearly. The innovation systems of the industrialised countries have developed in the course of the 20th century *co-evolutionarily* with their national political systems, have assumed, stabilised, and firmly established a country-specific character. It is because of this close interweaving with the political systems that one speaks of „national innovation systems“. In the last few years however, the discussion has widened to include

regional and sectoral innovation systems and their role, and more and more public policies have been developed at these levels[8].

The historical development and present shape of a „national" system of research and innovation reflect, to a certain extent, the character of the related political system and its governance[9]: centralist nations like France established an innovation system focusing quite clearly on its centrally constituted political system. By contrast, the research and innovation systems of federally constituted nations like the USA or Germany are rooted in relatively strong regional infrastructures, institutions and related governance mechanisms. Regional political as well as research institutions (in particular universities) enjoy a high degree of autonomy; one of the major historical achievements of national governments in such environments was the establishment of considerable „transversal" infrastructures on top of the regional settings, like the national institutions for basic research, huge national technological research centres, national project funding for industrial research etc. Along with this „division of work" between regional and national levels, the larger federally constituted countries also developed institutional platforms for negotiations across levels and institutions. The German „*Bund-Länder-Konferenz*" (the Federal Government and the States Conference on Education Planning and Research Promotion) may serve as an example: for decades it has been facilitating an alignment of procedures, quality criteria etc. for science and education between the federal states and the national government – but at the same time the in-built need for the production of consensus has brought along also a dangerous propensity to institutional conservatism, hampering e.g. a modernisation of the university system, repeatedly and urgently called for by experts[10].

After the second world war, and increasingly since the 1970s, with the triumph of „high technologies", the industrialised countries developed a broad spectrum of technology policy intervention measures and sparked off a „tech-

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8 The German *Land* Baden-Württemberg is often cited here as an example.

9 Amable et al. (1997), for instance, differentiate various types of governance („market-driven"; „government regulated"; „social democratic"; „meso-corporatist") and of characteristics (specialisation in science and technology; sectoral specialisation; labour relations/education; financial system; performance; regulatory system; preferred innovation types, and innovative sectors).

10 The same may be said about the *Domänenkompromiss* between the big German research institutions, represented by the regular „Presidents Meeting" (Hohn/Schimank, 1990).

nology race“[11]. The spectrum of implemented instruments of research, technology and innovation policy is widely differentiated in the meantime, reflecting the scope of institutions and interests involved (see exhibit 2): it stretches from public funding of research institutions over various forms of financial incentives to the conducting of research and experimental development in public or industrial research labs, up to the design of an „innovation-oriented“ infrastructure, including the institutions and mechanisms of technology transfer. In many European countries, these instruments dominated the practice or research and technology policy for the last three decades[12]. As further instruments one could mention efforts to guide public demand, measures in education and further training and the regulatory[13] possibilities available.

Summing up: while one might question the precise extent of the state's and related institution's role in research and innovation policy-making, most authors accord at least some significance to the state as a locus of political authority and recognize the need to re-theorize the state in this context[14].

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11 Cf. Roobeek, 1990; see also the classical overview by Ergas, 1987.

12 E.g. OECD, 2000; EU Commission, 2001; Larédo/ Mustar, 2001.

13 Since a couple of years the regulators dimension of research and innovation policies has been attracting more atention (e.g. Kuhlmann et al., 1998; Blind, 2001a, 2001b).

14 See e.g. Jasanoff (1997, xx): „Some authors treat the state as one among several structurally independent actors engaged in defining science and technology policy and competing with them for credibility, legitimacy and power. Others conceive the state as an aggregation of institutions, each of which can shape the political agenda through its capacity to produce information, control resources or form alliances with other actors. Still others see the state as discursively constituted through its various engagements with other knowledge-producing entities, including industry, scientists, professional organizations and social movements“.

*Exhibit 2: Instruments of Public research and innovation Policy*

| *Instruments in a narrow sense* | *Instruments in a broader sense* |
|---|---|
| 1. Institutional funding<br>• National Research Centres<br>• Research Councils ( in Germany DFG; Max Planck Society)<br>• Applied Research and Techn. Development Organisations (in Germany e.g. Fraunhofer Society)<br>• Universities and other Higher Education Institutions<br>• Others<br><br>2. Financial incentives<br>• Indirect promotion programmes (e.g. CIM)<br>• Technology promotion programmes (co-operative R&D projects)<br>• Risk capital<br><br>3. Other infrastructure and technology transfer mechanisms<br>• Information and consultancy for SMEs<br>• Demonstration centres<br>• Technology centres<br>• Cooperation, networks, people | 4. Public demand and procurement<br><br>5. Corporatist measures<br>• Long-term visions; technology foresight<br>• Technology assessment<br>• Awareness initiatives<br><br>6. (Continuing) education; training<br><br>7. Public policy<br>• Competition policy<br>• (De-) Regulation<br>• Public stimulation of private demand |

Source: Meyer-Krahmer/Kuntze 1992, 103

### *Policymaking challenged*

Public and private policymakers, both deeply rooted in the institutional settings of the innovation system, are facing a number of challenges, both now and in the future (see also Lundvall/Borrás 1998):

(1) *The nature of technological innovation processes is changing*. The production of highly sophisticated products makes increased demands on the science base, necessitating inter- and trans-disciplinary research and the fusion of heterogeneous technological trajectories (Grupp, 1992; Kodama, 1995). New patterns of communication and interaction are emerging which researchers, innovators and policymakers have to recognise and comprehend. For example, if nanotechnology (miniaturisation) is to stimulate future innovation processes and new generations of technology as a new basic technology, an important precondition is transdisciplinary interaction with electronics, information technology, the science of materials, optics, biochemistry, biotechnol-

ogy, medicine and micromechanics. The applications of nanotechnology accordingly encroach upon the fields of customised materials and biotechnical systems, even though they are envisaged as falling mainly into the area of electronics.

(2) *The „soft side of innovation" is of growing importance* (den Hertog et al., 1997; Coombs, 1999; Smits, 2002). Non-technical factors such as design, human resource management, business re-engineering, consumer behaviour and „man-machine interaction" are critical to the success of innovation processes. As a consequence, the learning ability of all actors in the innovation process is challenged and it becomes more appropriate to speak about a „learning economy" than a „knowledge-based economy" (Lundvall/Borrás, 1998, 31).

(3) These first two points may be specific manifestations of the decline of the „linear model" of innovation – Gibbons et al. (1994) called this the transition from *mode-1 science to mode-2 science*[15]. Mode-1 refers to traditional science-driven modes of knowledge production. Mode-2 refers to knowledge production processes stimulated and influenced far more by demand, in which many actors other than scientists also have important and recognised roles to play. There are a couple of similar catchwords like the „post-modern research system" by Arie Rip (2002), „post-normal science" by Silvio Funtowicz and J. Ravetz (1993; also Funtowicz, 2001) or „post-academic science system" by John Ziman (2001). It is an open question yet to which extent these notions are appropriate or not – in any case they try to pinpoint an on-going change in the research and innovation world across all industrialised countries, that is characterised by more cooperation, intensified networking, increasing interdisciplinarity.

(4) Science, research and innovation are becoming „bureaucratised" semi-industrial activities: „The transition from academic to post-academic science is signalled by the appearance of words such as management, contract, regulation, accountability, training, employment, etc. which previously had no place in scientific life" (Ziman, 2001, 82). The pressure on research and innovation systems to function more effectively is complemented by similar pressures to function more efficiently, largely driven by the growing cost of science and technology. This will require a much *better understanding of the „post-modern" research system itself* (Rip/van der Meulen, 1996).

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[15] See also Nowotny et al., 2001.

(5) Since the 1990s, industrial innovation processes *care less and less about national systems* and borders[16]. In particular big multinational companies developed from an „optimizing production machinery" to „globally learning corporations" (Meyer-Krahmer/Reger, 1999). Also, innovation managers in large multinational corporations run their strategies vis-à-vis heterogeneous national innovation policy arenas with diverse actors, not at least a variety of non-governmental organisations.

(6) With a European dimension, research and innovation policymakers compete but also try to co-ordinate or orchestrate their interventions with an *increasing range and number of actors* in mind (e.g. European authorities; various national government departments and regional agencies in an expanding number of member states; industrial enterprises and associations; trade unions and organised social movements etc.). Furthermore, the accession of new Eastern European member states will undoubtedly increase the importance of this aspect (Kuhlmann, 2001b).

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[16] See Edler et al., 2001; Reger et al., 1999; OECD, 1999b; Reinicke 1998.

## 3. Rationales of Public Research and Innovation Policies

„For centuries, governments have pursued policies to improve the innovative performance of domestic industry and to enhance the economic returns to domestic firms and citizens from indigenously developed technologies" (Mowery, 1994, 7). On a highly aggregated level, this phrasing might be considered as the basic rationale underlying any public research and innovation policy: to improve the innovative performance in order to increase the national resp. *societal welfare*. Since the early 1960s, thereby, the guiding idea has been that *„market failure"* leads to under-investment in research thus providing the principal rationale for state funding of research and innovation (Arrow, 1962; Nelson, 1959). This basic rationale gets blurred, nevertheless, due to an inevitable *„elusiveness" of public interventions* in science, research, technology, and innovation; it is fuelled by three major sources (Jasanoff, 1997, xiv):

1. There is a lingering *uncertainty about the boundaries of research and innovation policies* which could „with little imagination be stretched to encompass virtually every aspect of purposive state activity: health, education, welfare, defence, energy, environment".

2. The relative *autonomy of science* and technological progress (Kuhn 1962) – since the 1950s ideologically reinforced by Vannevar Bush's rule of independent expertise[17] – destabilises the very meaning of policy which is conventionally defined as a plan of action that is intended to determine people's behaviour.

3. The third source of elusiveness of research and innovation policy is the *fragmentation of the „nation state"*. Both knowledge and money are increasingly mobile, questioning the remaining degree of sovereignty of national research and innovation political authorities[18], thus undermining traditional rationales of political control.

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[17] Not at least following Vannevar Bush's 1945 report to the US president, *Science: The Endless Frontier*, where he argued that the United States should establish a national research foundation (Bush 1946). For the past half century, the „academic" part of the research community has claimed a special status for basic research (not applied research and innovation) as an activity that stands outside society and at the same time brings social and economic benefits. These benefits cannot be programmed, they say, because they arise in random ways.

[18] E.g. Strange, 1996; Edler, 2002; Kuhlmann, 2001b.

Taking a closer look at the actual policy initiatives launched on national, regional or transnational levels, one finds a considerably differentiated scope of heterogeneous rationales nurturing the policy-makers' intentions.

### *Economic paradigms of public funding*

Barry Bozeman (2000) made an attempt to condense the heterogeneous strands of economic rationales – with a particular focus on US technology transfer policies – by developing a concept of three competing paradigms (or rationales), the market failure paradigm, the mission paradigm, and the co-operative policy paradigm (see exhibit 3):

The *market failure paradigm* is based on neo-classical economics: following its core assumptions, markets are the most efficient allocator of information and technology, but there are various reasons why enterprises could fail to invest in research and innovation with reasonable prospects of commercial viability, in particular (OECD 1995, 17): „(i) Externalities: firms cannot 'appropriate' the full social benefits of R&D investment as private financial gains. (ii) Indivisibilities: the minimum size of R&D investment required is too great for the financing resources of individual firms. (iii) Risks: the risks of failure with the proposed R&D are too great for any individual firm to accept, but would be acceptable for a government with a much larger overall investment portfolio, or one with wider priorities". Following this view (e.g. Branscomb 1993, 72) government-supported laboratories are supposed to limit their activities to market failures such as extensive externalities, high transaction costs, and information distortions. Universities should provide basic research, in line with a private sector under-supply due to market failures (i.e. inability to appropriate the results of basic research directly).

*Exhibit 3: Three competing technology policy models (in the US) (Source: Bozeman 2000)*

| *Market failure* | *Mission* | *Co-operative technology* |
|---|---|---|
| *Core assumptions*<br>(1) Markets are the most efficient allocator of information and technology.<br>(2) Government laboratory role limited to market failures such as extensive externalities; high transaction costs; and information distortions. Small mission domain, chiefly in defence. Universities provided basic research, in line with private sector under-supply due to market failure (inability to appropriate directly the results of basic research). (3) Innovation flows from and to private sector, minimal university or government role. | (1) The government role should be closely tied to authorized programmatic missions of agencies.<br>(2) Government research and development (R&D) is limited to missions of agencies, but not confined to defence. University R&D supports traditional roles of land grant universities such as agricultural or engineering extension, manufacturing assistance and contract research for defence or energy research.<br>(3) Government should not compete with private sector in innovation and technology. But a govern-ment or university R&D role is a complement. | (1) Markets are not always the most efficient route to innovation and economic growth.<br>(2) Global economy requires more centralized planning and broader support for civilian technology development.<br>(3) Government laboratories and universities can play a role in developing technology, expecially pre-competitive technology, for use in the private sector. |
| *Peak influence*<br>Highly influential during all periods. | 1945-1965; 1992-present | 1992-1994 |
| *Policy examples*<br>De-regulation; contraction of government role; R&D tax credits; capital gains tax roll back. Little or no need for federal laboratories except in defence support. | Creation of energy policy R&D, agricultural labs, and other such broad mission frameworks. | Expansion of federal laboratory roles and university role in technology transfer and cooperative research and other technology-based economic development programs. |
| *Theoretical roots*<br>Neo-classical economics | Traditional liberal governance with broad definition of government role. | Industrial policy theory, regional economic development theory. |

This paradigm – conceding government interventions only a modest role – has been highly influential during all periods (in particular in the US): not least since the accumulated experience of several decades of technology policy, together with advances in economic innovation theory, has revealed limits of too naive „market failure" assumptions as a basis for policy-making: there are obvious „government failures" – such as institutional inertia, lack of reliable information (on efficiency and impacts of policies etc.), lack of continuity and long-term perspective, red-tape procedures, rivalry of bureaucracies (see e.g. Gielow/Krist/Meyer-Krahmer, 1985) – that have forced evaluators and policy-makers in accounting also for the considerable cost of public programmes including those originating from distorted market dynamics (Papaconstantinou/Polt 1997, 11).

The *mission paradigm* is theoretically based on traditional liberal governance concepts: the government should concentrate on research and innovation in service of well-specified missions in which there is a national interest not easily served by private research, in the US mainly concentrated on the *defence* area, but not confined to it: missions such as *energy* production and conservation, *medicine* and public *health*, *space*, and *agriculture* have expanded the role of universities and federal labs. This paradigm has been highly influential between 1945 and 1965, and 1992 until present (in the US). In Europe, the UK and in particular France have been following the mission paradigm for decades (Ergas 1987).

The *co-operative policy paradigm* is theoretically based on industrial policy theory, and regional economic development theory: markets are not considered to be always the most efficient route to innovation and economic growth. Increased competition in the global economy requires more centralized planning and broader support for civilian technology development. Government laboratories and universities have to play a strong role in developing technology, especially in the area of „pre-competitive research and innovation", creating knowledge spill-overs for further use in the private sector. In the US, this paradigm was influential between 1992-1994, while in Europe it has been playing an important role for decades. Examples are the expansion of American federal laboratory and university activities in technology transfer, and co-operative research and other technology-based economic development programmes, like most of the „Specific Programmes" under the European Commission's Framework Programmes, or the „*Verbundforschungsförderung*"

(co-operative research between public sector institutes, universities, and industry) in Germany since the mid-1980s.

Bozeman's co-operative policy paradigm may be considered as a variation of another strand of reasoning: it starts from the realisation that often the benefits of individual programmes or policies can be understood only in the context of their impact within complex innovation systems. The related notion of *„systemic failure“* may be „translated into the more elaborate principle of 'behavioural additionality', which is intended to capture the many ways in which participation in a programme can change the innovative behaviour of a firm“ (Papaconstantinou/Polt, 1997, 11). An overview of typical functional failures of complex innovation systems has been presented by Martin and Scott (2000). Such dysfunctions may differ from sector to sector, depending on market and technology characteristics, and relate to a variety of innovation modes: the development of inputs for using industries; the application of inputs developed in supplying industries; the development of complex technical systems; or the application of high-science-content technology. Characteristic sources of innovation failures are the limited appropriability of technologies and knowledge (in particular of SMEs), cost, risk and insufficient information. Typical public policy responses to systemic dysfunctioning range from the co-funding of research cooperation, through the establishment of bridging institutions between companies and research or development providers, to the support for venture capital markets.

Focussing on European approaches, Rothwell/Dodgson (1992) sketched a historical development of research and innovation policies widely complementary with Bozeman’s three paradigms: starting from the rather separated spheres of science policy (related to the market failure paradigm) and industrial policy (mission paradigm) of the 1950s and 60s, the dominating rationale since the 1980s shifted to a growing inter-departmental co-operation, accompanied by a stronger innovation orientation, including a considerably strengthened regional and (within the EU) transnational dimension, i.e. towards initiatives following mainly the co-operative policy paradigm, orientated at curing systemic failures.

Among the co-operative (Bozeman), the inter-departmental (Rothwell/ Dodgson) or systemic failure type of research and innovation policy rationales, in Europe the peculiar case of transnational research and innovation initiatives of the last two decades has to be emphazised: the European Union's research

and innovation policy initiatives are – officially – restricted to, and concentrated on, the creation of „European added value“ (e.g. Luukkonen, 2000). They are supposed to follow the „subsidiarity principle“, so as to select only those objectives which are most efficiently pursued at Union level. More precisely, projects should – beyond their quality in terms of scientific criteria, partnership, and project management – (1) contribute to create a „critical mass“ of human and financial resources across all the member states; (2) or guarantee a significant contribution to the implementation of one or more Community policies; (3) or address problems arising at Community level including social needs, or questions relating to standardisation or the development of the European area. Moreover, Community research, technology and innovation programmes and projects claim to contribute to the economy, science and technology in ways that will encourage the harmonious and sustainable development of the Community as a whole.

### *Other rationales of public funding*

Actually, public science, research and innovation policy has a longer history than the economist's debate on its legitimacy (Arrow, 1962). There are a variety of other – partly older – justifications which could be grouped along two major arguments: (1) a presumed need for structural change in the science, research and innovation system; (2) the contribution of research and innovation to the provision of „public goods“.

(1) The need for *structural change* in the research and innovation system: this argument relates closely to the notion of „innovation systems“ (and thus could also have been discussed in the context of „systemic failures“, above) and a presumed need of government initiatives aiming at overcoming sclerotic institutions and procedures e.g. in the academic research system. The structural conditions for clinical research at German university hospitals can be used as an illustrative example here (Kuhlmann, 1998): in the 1990s, clinical research was regarded as ineffective and underdeveloped, in an international comparison. By promoting interdisciplinary clinical research centres (ICRCs) the Federal Ministry for Education, Science, Research and Technology (BMBF) wanted to provide a lasting impetus to improve the situation. Within the framework of a competition, eight universities were selected which established pilot ICRCs in 1995/96. The federal funding was guaranteed for a certain time span (eight years), as degressive kick-off financing; the ICRCs were

supposed to be funded in the mid-term mainly by their universities and the responsible federal state government. The main targets of the BMBF programme are: (a) the establishment of efficient interdisciplinary clinical research structures; (b) the development of specific research profiles of the participating university hospitals; (c) qualified scientific training conditions for young clinical researchers; (d) qualitative and competitive allocation of public research funds; (e) transparent financial management of research on the one hand and medical care on the other.

(2) Science and technology for *„public goods"* are considered as a particularly important aim of public investments (OECD, 1995, 23): public goods can be created if the eventual outcomes of research and innovation will support social, non-economic goals such as equity and justice, market efficiency, health, knowledge, peace and security, cultural heritage – and in particular the search for a more sustainable development, including sustainable ways of using „human resources" and consuming natural resources – hence areas which cannot sufficiently be served by free markets.

Experts in favour of a strong „public good" rationale for research and innovation policies[19] have argued that forced by tightened international competition between national or regional innovation systems, these systems' innovation policies are running the danger of focussing their efforts too narrowly on the competitive advantages of certain local „attractions", thus finally accelerating the global competition, irrespective of individual, social, ecological or cultural impact. Following this line of arguments, future innovation policies that could contribute to the production of global public goods would have to meet a dual challenge: first, international co-operation in science, technology and innovation would have to be transformed from its traditional place as „external affairs" into efforts on the domestic policy-making agenda. Second, „post-national" innovation policies, on national, regional or transnational levels, would have to „internalise externalities", i.e. to develop concepts and instruments needed to overcome problems of collective (global) action in order „to deal with potentially contagious phenomena at the source, before they spill across borders" (Kaul et al., 1999: xxv).

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[19] E.g. Sweeny, 2000; Kuhlmann/Meyer-Krahmer, 2001.

## 4. Governance of the Research and Innovation Policy Arena: an Institutional Analytical Concept

The paradigms, rationales, and justifications of public research and innovation policies discussed in the above sections are rather conceptual and *normative constructions*, disregarding widely the actual and often hidden agendas of actual policy-making situations. Quite often the question remains open whether research and innovation policy-makers are principals or agents in the arena[20]. The diverging rationality and the influence of pressing peer groups from the science system, from industry or from the „critical public" may be considerable in many cases – hence confusing the causal relationship between the normative construction of whether, why, and how public initiatives should have been taken and the actual policy outcomes. This will be discussed in the following section.

„Most technology policies ... represent a compromise among conflicting objectives" (Mowery, 1994, 10). Policy-making is only seldom a matter of top-down decision-making and straight-forward implementation; rather it can be modelled as a process of competition, networking and attempts at consensus-building between heterogeneous (corporatist) actors representing different societal subsystems. Frequently, policy decisions are negotiated in multi-actor arenas and related networks (Marin/Mayntz, 1995) which may stretch over multi-level politico-administrative systems. Typical perspectives of relevant corporatist actor groups represented in the research and innovation policy arena are (see exhibit 4):

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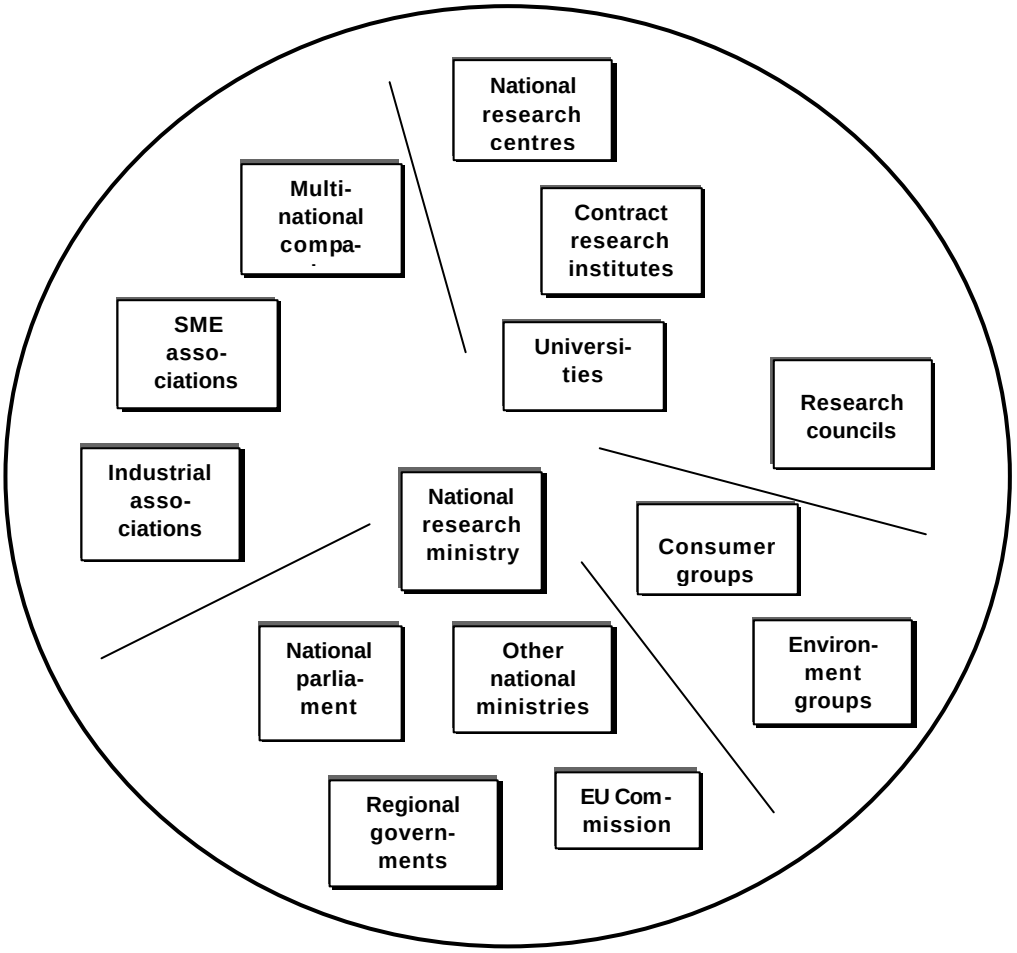
[20] E.g. Braun, 1993; van der Meulen, 1998.

*Exhibit 4: Research and innovation policy arena: competing (corporatist) actors and no dominant player*




(1) *Science institutions:* the science system is represented by universities (faculties, institutes, or research groups), non-university public research institutes (basic or applied research), or related professional associations like science councils (depending on their role in the national research system), rectors' conferences etc. Typical interests of science actors with respect to publicly funded research are a further development of the involved researchers' scientific reputation and academic career (by scientific publications, participation in conferences, etc.), the consolidation and extension of a given disciplinary or thematic area, the training of young researchers, and the like.

(2) *Industrial institutions:* the world of technology or knowledge seeking industrial companies is represented by research and development labs of big (multinational) enterprises, or by industrial research associations – only seldom by individual smaller companies (in policy arenas). Typical interests are the exchange of pre-competitive technological knowledge, the creation of new knowledge through research co-operation with other companies or public institutes, the joint development of technical norms and standards, but also the immediate appropriation of new knowledge (patents) and the realisation of new products and processes in markets (successful innovation).

(3) *Societal institutions*, in principle, should be represented by democratic politicians (see below), but due to a continued differentiation of societal interests, an increasing diversity of relatively well organised interest groups, non-governmental organisations (NGOs), and environmentalists has been interfering in innovation policy arenas seeking for active participation, recently in particular in the area of life sciences and research on medical applications of genomics. As a consequence of the heterogeneous nature of NGOs' purposes and perspectives, it is difficult to highlight „typical" societal interests in research and innovation policies.

(4) The *politico-administrative system* is represented in innovation policy arenas by members of the parliament, governmental institutions and related bureaucracies, each differently constructed and empowered on national, regional (e.g. German *Länder*; French regions), and transnational levels (European Parliament; Council of Ministers; EU Commission). Politico-administrative systems are characterised by a tripartite setting of actor perspectives and interests: parliamentarians, but also government representatives engaging in research and innovation policies are widely attracted by the (potential) attention of strong public interest groups (industry, NGOs, ...); innovation policy bureaucrats, on the other hand, rather seek to stabilise their institutional „biotope" and strive for legitimisation of their actions – partly through alignment with parliamentary or government goals, partly by seeking consensus with their major „clients" in science and industry. Hence, institutional and procedural conservatism may be mentioned as the most stable „typical" interest of research and innovation policymakers and bureaucrats, whereby in terms of policy „content" (i.e. research themes, technologies, ...) they might afford more flexibility than „science" and „industry", defining themselves by content rather than by procedure.

What *room for manoeuvre* do related actor groups actually have in this arena? A precondition for a sober analysis is a thorough understanding of the

*actual governance* in a historically given arena. How to achieve this understanding? From a methodological perspective one may employ the concept of the Actor-Centred Institutionalism („akteurzentrierter Institutionalismus") developed by Renate Mayntz, Fritz Scharpf and colleagues[21]. Here institutions are defined as sets of rules feeding the actors with reliable expectations and social sense. In their concept however, Mayntz and Scharpf model reliability only with respect to regulatory and not to normative or cognitive aspects. In order to explore also the dynamics of emerging new actor constellations and institutional settings we consider it necessary to analyse also „soft" forms of social rules, not yet frozen into codified regulations. Following Scott (1995) one can conceptualise institutions as sets of rules of a regulatory, normative or cognitive character providing stability and meaning to social behaviour, transported by various carriers like cultural patterns or routines. Institutions guide human behaviour by (1) utility-oriented rules which may be enforced by coercion („regulatory"), (2) norm-based obligations („normative"), and (3) immediate participation in taken-for-granted models of reality („cognitive"); institutions store historical experience in idiosyncrasies guiding the day-to-day action of their members[22]. This broadened definition of „institution" implies a notion of „governance" exceeding the classical definition of political control and steering. Recently Renate Mayntz identified two younger, broader definitions, (1) „a more cooperative mode where state and non-state actors participate in mixed public/private networks" and (2) „modes of coordinating individual actions, or basic forms of social order" (Mayntz, 1998), whereby the second definition includes both the classical steering idea as well as network-oriented „softer" aspects. The identification and reflection of the autodynamics and impacts of experiences inscribed in institutions may help to better understand the actual orientations and strategies of corporatist and other organised actors in the actual governance of research and innovation systems, thereby governance understood as a kind of evolutionary social order.

One can operationalise this concept by constructing a three-dimensional space of analysis[23] (see exhibit 5):

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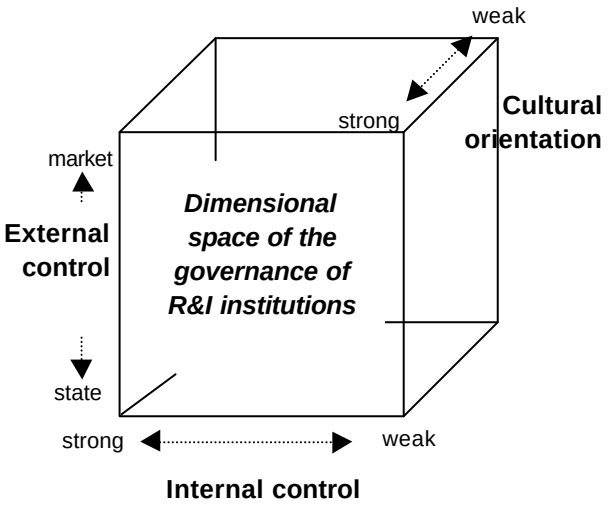
[21] Mayntz/Scharf, 1995; Scharpf, 2000.

[22] I.e. „scripts", „taken-for-granted-rules" (Powell/DiMaggio, 1991; Scott, 1995) embedded in „Leitideen" (Lepsius, 1995).

[23] See also Braun/Merrien (1999, 22ff), with a comparative analysis of the governance of universitities; also Crouch/Trigilia (2001, 230f), on the governance of local economies.

*Exhibit 5: Dimensional space of the governance of research and innovation (R&I) institutions (based on Braun/Merrien, 1999, 23)*




- *Internal control*, i.e. character of self-management of organisations resp. of corporatist actors, e.g. centralist management vs. autonomy of individual units; competitive vs. institutional allocation of resources; professional career patterns (e.g. academic, industry-oriented, administrative), incentives (e.g. financial incentives; degree of independence and room for manoeuvre of research and innovation).
- *Cultural orientation* of an organisation resp. corporatist actor, thus the „belief system", the „Leitidee" and „taken-for-granted-rules"", the „mission". Such orientations my be expressed both in official (political) documents (see e.g. the website of the German Fraunhofer-Gesellschaft) and in the orientation of individual staff members.
- *External control* of organisations resp. corporatist actors by way of regulatory measures (imposed by state agencies) or market mechanisms. The recent merger of the previous German national research centre „Gesellschaft für Mathematik und Datenverarbeitung (GMD)" into the Fraunhofer-Gesellschaft in 2001 provides one of the few examples of a massive state intervention (here by the federal research ministry). Beyond one may

consider strong technological and market dynamics, like in the area of bio- and nanotechnologies, as a strong external factor.

To sum up, negotiating actors with different responsibilities (policy-makers define programmes, allocate budgets; researchers define themes, purchase equipment; industry looks for competitive advantages ...) pursue different – partly contradicting – interests, represent different stakeholders' perspectives, construct different perceptions of „reality" (e.g. Callon, 1992), refer to diverging institutional „frames" (Schön/Rein, 1994). Thereby, given power structures and the shape of arenas may vary considerably between national states (or regions) (see exhibit 4). Normally, „state" authorities in (regional, national, transnational) multi-actor arenas of innovation policy play an important, but not a dominant role. In many cases they perform the function more of a „mediator", facilitating alignment between stakeholders, equipped with a „shadow of hierarchy" (Scharpf, 1993), rather than operating as a top-down steering power. Eventually, „successful" policy-making means compromising through „re-framing" stakeholders' perspectives and joint production of consensus.

***Governance on meso-levels: pathologies and remedies***

Many policy analyses and evaluations prove that the actual meso-governance of politico-administrative systems in general and innovation policy in particular in most OECD countries is largely characterised by

- a high degree departmentalisation, sectoralisation of the political administration, and low inter-departmental exchange and cooperation;
- heterogeneous, non-inter-linked arenas: often corporatist negotiation deadlocks (e.g. health innovation related policy in Germany);
- failing attempts at restructuring responsibilities in government because of institutional inertia;
- dominance of the „linear model" of innovation in policy approaches (and of related economists as consultants) in many national authorities (e.g. ministries).

We find many *lock-in actor constellations* and related interest conflicts, within and between involved arenas. Policymakers striving for more „effective" initiatives still apply rather „instrumentalist" approaches. The instrumen-

talist view, however, of research and innovation policymaking is used up: according to Rip (1998) one indicator of the instrumentalist orientation towards „modernist" policymaking has been a request for „robust methods" that would allow policymakers to make a difference, to exert influence, to steer even – in other words, to act at distance. Rip reminds us of the subtitle of a famous book „How Great Expectations in Washington Are Dashed in Oakland" (Pressman/Wildavsky, 1973): the instrumentalist thrust tends to become counterproductive on its own terms because it neglects the complexities and the auto-dynamics of „post-modern" innovation processes.

In a recent paper, Ruud Smits and I (Smits/Kuhlmann 2002) classified research and innovation policy instruments into four categories: financial, diffusion-oriented, managerial, and systemic. Three of them are widely spread (financial, diffusion, managerial), the fourth category, that of systemic instruments, is under-represented in the portfolio yet. While the more traditional research and innovation policies, apart from their mission orientation, were basically legitimised by the concept of market failure, modern innovation policies also have to deal with system imperfections. There is a *need for horizontal and systemic policy co-ordination*. In short, this trend urges government to take part (and if necessary: take the lead) in the role of innovation system builder and organiser. Thereby, though, one should not overestimate the instrumentalist power of public policy vis-à-vis other actors in complex policymaking arenas.

Jacobsson and Johnson (2000), in an analysis of the innovation systems approach in energy systems, identified typical weaknesses of under-co-ordinated innovation policymaking: there is poorly articulated demand; local search processes which miss opportunities elsewhere; too weak networks (hindering knowledge transfer); too strong networks (causing 'lock in', dominance of incumbent actors); legislation in favour of incumbent technologies; flaws in the capital market; lack of highly organised actors, meeting places and prime movers. Based on their analysis they propose new – innovation-focused, systemic and co-ordinating – roles for government: supporting of different designs, safeguarding variety, addressing a large portfolio of technologies and innovations; strengthening linkages, management of interfaces, reinforcing of user-producer relations, building new networks and deconstructing old ones (creative destruction); stimulating learning processes; raising awareness, stimulating articulation of demand; monitoring the struggle between proponents of new technologies and incumbents of the old ones; stimulating

prime movers; taking care of (very) long time horizon related to institutional change. Thus, new modes of governance (and relatedly: government) would require a broader understanding of policies for innovation.

Thus in the future *new modes of governance* (and relatedly: government) would require a broader understanding of policies for research and innovation:

- organisation and content of governance would have to take into account the *systemic nature of research and innovation*, including the notion of complex, non-linear interaction (e.g. fostering university – industry co-operation rather than transfer units, stimulating multi-disciplinary research, fostering the debate on implications of mode 2 for universities and other institutions in the innovation system, more in particular with regard to missions, culture, reward structures, relations between institutions, quality control, ...)
- government and administration would have to deal more proactively with the challenge of *moderating cross-sectoral linkages* and supporting the (re-)structuring of cross-sectoral networks (e.g. horizontal taskforces, sectoral councils, UK-Foresight like activities, ...)
- this would include consequent attempts to *re-organise administrations* in a way that enables flexible horizontal co-ordination and exchange among formally divided entities (task-oriented mobility of staff, training of staff, changes in reward systems that stimulate horizontal initiatives, ...)
- a *holistic* notion of research and innovation policy, keeping in mind and taking advantage of the inter-dependence of single specific policy measures as well as the *inter-relation of different policy areas* (fostering cluster approaches, infrastructures facilitating the identification of and access to strategic intelligence, co-ordinating bodies with a real mandate, a parliamentary committee on innovation, …)
- more elaborated forms of institutionalised *co-ordination* between the *European* level on the one hand and the *national and regional level* on the other (e.g. initiating a political debate on the „division of labour" in the „European Research Area" between the various administrative levels resulting in clear decisions and strategies, furthering the development of networks of excellence, ...).

To sum up, normative research and innovation policy rationales (market failure; public goods; ...) – as discussed above – normally do not rule the de

facto behaviour of decision-making actors in policy arenas: rather such normative orientations are employed as one among several means of borrowing legitimisation, while decisions actually are driven by attempts at compromising between quite heterogeneous interests. Any evaluation benchmarking the success of a given policy referring exclusively to a fixed normative frame would run the risk of remaining a rather academic and quixotic exercise.

The governance on the meso-level of institutions – more in particular the interrelationship of key organisations and institutions – is the key issue determining the potential reach and limitations of public policymaking in research and innovation systems; this meso-governance is constantly, but mostly slowly evolving. The understanding of meso-governance requires systemically-oriented multi-perspective information and is a continuous task, drawing on network-based intellectual and research work. A policy-oriented product of this kind of analytical work is represented by the concept of *strategic intelligence*.

## 5. Mobilising Strategic Intelligence for Research and Innovation Systems

This lecture started with the guiding question: „To which extent and under which conditions can the institutional settings of research and innovation be deliberately shaped?" So far I discussed the need for a system approach to research and innovation, I reviewed several normative rationales for public policy in this area, and I drafted an analytical concept on the meso-governance of research and innovation systems – are there now any practical implications?

In the year 2000 his inaugural lecture Ruud Smits said on the mission of the Department of Innovation Studies, embedded in the Copernicus Institute for Sustainable Development and Innovation: „In our research programme we aim to achieve an effective balance between the development of new insights and to bring these insights into practice. Our intention is to gain insight into the way in which innovation processes become more complex and open against the background of the communalisation of decision-making processes. For instance: it is important how and which actors are involved in innovation processes, and which factors are taken into account; how the distribution of knowledge production takes place, how the borders in and between businesses shift, and what is the role of the stakeholder. We also intend to develop instruments on the basis of these insights that will be able to support the research and the actors involved" (Smits 2000). He sketched three lines of research, to be reflected also in the three study programmes of the Copernicus Institute, in particular the study programme Science and Innovation Management (NW&I). My research and teaching is intended to contribute to these three lines:

- Analysis of innovation processes and innovation systems;
- Critical reflection on innovation theories;
- Analysis and support of decision-making processes.

Thereby, I am focusing my research and teaching on the role of public and private policies in research and innovation systems, more in particular in the following areas: (1) 'Governance and Management of Research and Innovation Systems'; (2) 'Measurement and Performance Assessment of Research and Innovation Systems'; (3) 'Strategic Intelligence for public policymaking and industrial environments'.

Let me now – in the final section – touch upon the latter notion, the idea of *strategic intelligence*[24]. We define strategic intelligence as a set of – often distributed – sources of information and explorative as well as analytical (theoretical, heuristic, methodological) tools employed to produce useful insight in the actual or potential costs and effects of public or private policy and management. Over the last two decades, considerable efforts have been made to improve the design and conduct of effective research, technology and innovation policies. In particular, *formalised methodologies*, based on the arsenal of social and economic sciences have been introduced and developed which attempt to analyse past behaviour (evaluation), review technological options for the future (foresight), and assess the implications of adopting particular options (technology assessment):

- „Technology foresight is the systematic attempt to look into the longer-term future of science, technology, the economy and society, with the aim of identifying the areas of strategic research and the emerging of generic technologies likely to yield the greatest economic and social benefits" (Martin, 1995, 140)[25].
- Practices of science and technology policy evaluation are wide-ranging, and their functions vary significantly (1) from the provision of legitimisation for the distribution of public money and the demonstration of adequate and effective use of the funding by measuring the scientific/technological quality or the (potential) socio-economic impacts, via (2) targeting and „controlling" in the sense of improved management and „fine tuning" of science and technology policy programmes, to (3) an attempt to improve transparency in the rules of the game and the profusion of research funding and subsidies, and to enhance the information basis for shaping science and technology policies, in the sense of a government-led „mediation" between diverging and competing interests of various players within the science and technology system (see Kuhlmann, 1997)[26].
- Technology assessment, in very general terms, can be described as the anticipation of impacts and feedback in order to reduce the human and social costs of learning how to handle technology in society by trial and error.

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[24] Kuhlmann et al. 1999; Kuhlmann 2003.

[25] See also Cuhls et al., 2002; Grupp 1998.

[26] See also Bozeman/Melkers, 1993; Georghiou/Roessner, 2002; Cozzens, 2003; Feller, 2003.

Behind this definition, a broad array of national traditions in technology assessment is hidden[27].

Also, as a complement of evaluation, foresight and technology assessment, other intelligence tools such as comparative studies of the national, regional or sectoral „technological competitiveness", benchmarking methodologies etc. were developed and used[28]. Policymakers at regional, national and international levels exploited their results in the formulation of new policies. Increasingly, however, it has become obvious to both policymakers and the analysts involved in the development and use of strategic intelligence tools that there is a need to use such tools in more flexible and intelligently combined ways, thereby exploiting potential synergies of the variety of strategic intelligence pursued at different places and levels across countries.

### *General principles of strategic intelligence*

The provision and the application of strategic intelligence should follow a number of *general principles*:

(1) *Principle of participation*: strategic intelligence realises the multiplicity of actors' and stakeholders' values and interests involved in innovation policy-making. Foresight, evaluation or technology assessment exercises take care of the diversity of perspectives of actors and make an attempt to give them a voice (multiple perspective approach). Strategic intelligence avoids maintaining one unequivocal „truth" about a given innovation policy theme.

(2) *Principle of „objectivisation"*: strategic intelligence „injects objectivised" information into the policy arena, i.e. the results of policy/strategy evaluations, foresight exercises or technology assessment, and also of analyses of changing innovation processes, of the dynamics of changing research systems and changing functions of public policies. Thus, strategic intelligence facilitates a more „objective" formulation of diverging perceptions by offering appropriate indicators, analyses and information-processing mechanisms.

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[27] See Schot/Rip, 1997; Loveridge, 1996; Smits et al., 1995.

[28] See e.g. the OECD's Science, Technology and Industry Scoreboard; the European research policy benchmarking (EU Commission 2001); the „European Innovation Trendchart" at http://trendchart.cordis.lu; or the „European Benchmarking Inititatives" at http://www.benchmarking-in-europe.com.

(3) *Principle of mediation and alignment*: strategic intelligence facilitates debates and „discourses“ between contesting actors in related policy arenas, thus mediating and „moderating“, supported by „objectivised“ information to be „digested“ by the struggling parties. Mutual learning about the perspectives of competing actors and their interest backgrounds can ease an alignment of views.

(4) *Principle of decision support*: strategic intelligence requires forums for negotiation and the preparation of policy decisions. The outcome of participatory, objectivised and mediated alignment processes will facilitate political decisions – not least as a response to the political quest for democracy vis-à-vis technological choices –, and effectuate the successful subsequent implementation.

A *practical case* of the use of advanced instruments of strategic intelligence for research and innovation policymaking is represented by the German process „Futur – the Research Dialogue” (www.futur.de). Futur is a foresight process, presently run on behalf of the German Federal Ministry of Education and Research (BMBF). It is conceived as a means of priority-setting for future innovation-oriented research policies and related funding. Future funding priorities – manifested in „Lead Visions”' (*Leitvisionen*) – are intended to be based on identified societal needs. Hence Futur is conceptualised as a participatory process, including about 1500 people from research, industry and other societal organisation – both „experts” and „non-experts” – collaborating creatively a in series of conferences, workshops, “focus groups” and an internet “web-space”. Four Lead Visions have been identified yet and are supposed be translated into funded research programmes or projects soon. The underlying goal of this strategic intelligence exercise is to unsettle the present meso-governance of priority-setting in the ministry, characterised by institutional inertia, a high degree of departmentalisation and “closed shop” mentality. Exhibit 6 provides a short description of the process.

*Exhibit 6: the German „Futur-Prozess", a case of advanced strategic intelligence*

The German foresight process called „*Futur*" is run on behalf of the German Federal Ministry of Education and Research (BMBF) as a means of priority-setting for future innovation-oriented research policies. *Futur* is oriented towards the identification and inclusion of societal needs in future research agendas. „Lead visions" (*Leitvisionen*) are supposed to be the major outcomes of the process which shall be translated into funded research programmes or projects. The participation of people from research, industry and other societal groups – including „non-experts" – in various kinds of workshops and the combination of different communication and analytical methodologies are key characteristics of the process. *Futur* started out in 2001 and has been generating priority suggestions for ministerial research funding until the end of 2002; afterwards the process may be re-iterated. My group at ISI is involved in the process as a methodological advisor.

*Futur* is intended to introduce „fresh ideas" into the research-funding portfolio of the BMBF, by way of opening up the traditional mechanisms for agenda-setting and prioritisation. The conventional process is characterised by a close and rather intransparent interaction between research institutions, industry, programme agencies (*Projektträger*) and ministerial bureaucrats in charge of research funding (representing not at least a principal-agent issue; see Braun 1993). Strategists within the ministry were increasingly concerned about the risk of missing important new issues on the funding agenda if it were solely made up on the basis of traditional mechanisms.

Futur is directly linked to BMBF priority setting. So far four „Lead Visions" (Leitvisionen, desirable visions for the future) have been worked out in such a way that they can be directly translated into projects or programmes: "Create Open Access to Tomorrow's World of Learning"; "Living in the Networked World: Individual and Secure"; "Healthy and Vital throughout Life through Prevention"; "Understanding Thought Processes".

The participation of persons from outside BMBF (experts and "non-experts") is a crucial component in order to bring in new ideas and link them with BMBF programmes. The outcomes of *Futur* are supposed not only to be linked with disciplines and technologies, but to be *more systemic by character* and interdisciplinary by nature. This implied that the exercise had to be more need-driven and problem-oriented, but at the same time open to future developments.

The Futur process is still running. Presently an evaluation is conducted by an independent international panel of foresight experts making a first assessment of the appropriateness and effectiveness if the instrument. The answers to two key questions will have a decisive impact on Futur's success: (1) How truly 'innovative' are the Futur-generated thematic areas for research funding? Some hints have been made that most of the thematic areas debated within Futur so far are already covered in one way or the other by a variety of research funding institutions. (2) Will the ministry (the minister and the bureaucrats interwoven with their research clients) actually take up and implement the Futur-generated Leitvisionen, and equip it with substantial funds? Will the main institutional actors in the research and innovation arena finally take up Futur-generated themes?

It is quite obvious that a better knowledge of the actual meso-governance in the research and innovation system would help to adapt and improve strategic intelligence instruments like Futur.

### *Distributed strategic intelligence*

Analysts, policymakers and other actors involved in research and innovation processes use or have access only to a small share of the strategic intelligence of potential relevance to their needs, or to the tools and resources necessary to provide relevant strategic information. Such assets, nevertheless, exist within a wide variety of institutional settings and at many organisational levels,

though scattered across the globe. As a consequence, they are difficult to find, access and use. Hence, rectifying this situation will require major efforts to develop interfaces enhancing the transparency and accessibility of already existing information, and to convince potential users of the need to adopt a broader perspective in their search for relevant intelligence expertise and outputs.

Consequently, an architecture and infrastructures of *distributed intelligence* must allow access, and create inter-operability across locations and types of intelligence, including a distribution of responsibilities with horizontal as well as vertical connections, in a non-hierarchical manner. Such an architecture of distributed strategic intelligence would, at least, limit the public cost and strengthen the „robustness" of intelligence exercises. Robustness, nevertheless, presupposes also provisions for quality assurance, boosting the trust in distributed intelligence based debates and decision-making. Five *general requirements* of infrastructures for distributed intelligence can be stipulated:

(1) *Networking requirement*: the architecture of „infrastructures" for distributed intelligence should neither be designed as one monolithic block nor as a top-down system – rather the opposite: ideally the design allows for *multiple vertical and horizontal links* amongst and *across the existing* regional, national, sectoral, and transnational *infrastructures* and facilities of the related innovation systems and policy arenas.

(2) *Active node requirement*: in order to guarantee a sustainable performance of distributed intelligence and to avoid hierarchical top-down control, the architecture would have to offer active brokering „nodes" (or „hubs") for managing and maintaining the infrastructure. *Three types of active nodes* can be distinguished: (a) The first type provides *enabling facilities*, e.g. a „foresight bank" for policymakers, research institutions, non-governmental organisations, or enterprises. Another promising facility is the new „Policy Laboratory" established in the context of the Copernicus Institute for Sustainable Development and Innovation, here in Utrecht. (b) The second type of node offers a *„directory" allowing direct connections between relevant actors*, in order to facilitate exchange about the specific context of an intelligence exercise. (c) A third type of node offers a *„register" allowing free access to all strategic intelligence exercises* undertaken under public auspices. The variety of policy arenas and of problems addressed require information not only dedicated to a given „instrument", but centred on processes and on the

related combinations of instruments. Over time, the register would include more and more strategic exercises, requiring some structuring, so that reference to the register will make new exercises more relevant and/or less costly, hence facilitating *collective learning processes*.

(3) *Transparent access requirement*: clear rules concerning the access to the infrastructure of distributed intelligence have to be defined, spanning from *public domain* information areas to *restricted services*, accessible only for certain types of actors or after charging a fee.

(4) *Public support requirement*: in order to guarantee a high degree of independence the distributed intelligence infrastructure is in need of a regular and reliable support by public funding sources. This applies in particular to the basic services provided by the „brokering nodes"; adequate resources will make them robust. It does not, however, prevent the node providers from additionally selling market-driven information services, thus extending their financial base.

(5) *Quality assurance requirement*: how can actors in policy arenas trust in all the „intermediaries" mobilised in the course of the preparation or conduct of policymaking? Three major avenues of quality assurance can be followed: (a) A basic source of quality assurance would have to be guaranteed through a reliable support with *repeated and „fresh" strategic intelligence exercises* (e.g. evaluation, foresight, technology assessment) and new combinations of actors, levels, and methods initiated and funded by innovation policymakers across arenas and innovation systems. (b) A second means of quality assurance is the establishment of *accreditation mechanisms* for providers of strategic intelligence, based on a self-organising and vivid „scene" of experts. (c) bottom-up processes of institutionalisation amongst the providers of strategic intelligence may play a crucial role, in particular *professional associations* (like e.g. the American Evaluation Association, the European Evaluation Society, and the growing number of national evaluation associations that have been established since the 1990s). Also, scientific and *expert journals* are indispensable means of maintaining and improving the professional level of services. Furthermore, education and training in the area of strategic intelligence for innovation policy have to be extended and improved, in particular on various levels of *university teaching*, like the „Science and Innovation Management" (NW&I) programme.

Personally, I try to contribute to the production of useful strategic intelligence through my research, but also by mobilising distributed intelligence in our area, mainly through two channels: one is the collaboration with my home base, the Fraunhofer-Institute for Systems and Innovation Research (ISI) in Karlsruhe, and there in particular with my Department „Technology Analysis and Innovation Strategies". The other channel is a continuos cross-linking with the many academic and research organisations and networks across Europe and in other parts of the world, by making the Department of Innovations Studies at this university an *intellectual hub* and platform for gathering and developing, focusing, deepening, profiling, editing, and communicating knowledge in our area. Not at least, Utrecht can contribute to the creation of a *new breed of innovation policymakers*, in public and private sectors, capable of working in a reformed, systemically inter-linked institutional setting, fostering experimentation and learning, thereby exploiting sources of strategic intelligence – hence realising a „high quality" governance for innovation.

Many thanks for your attention!

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