Strengthening Interfaces in Innovation Systems: rationale, concepts and (new) instruments

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With contributions of

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Abstract:

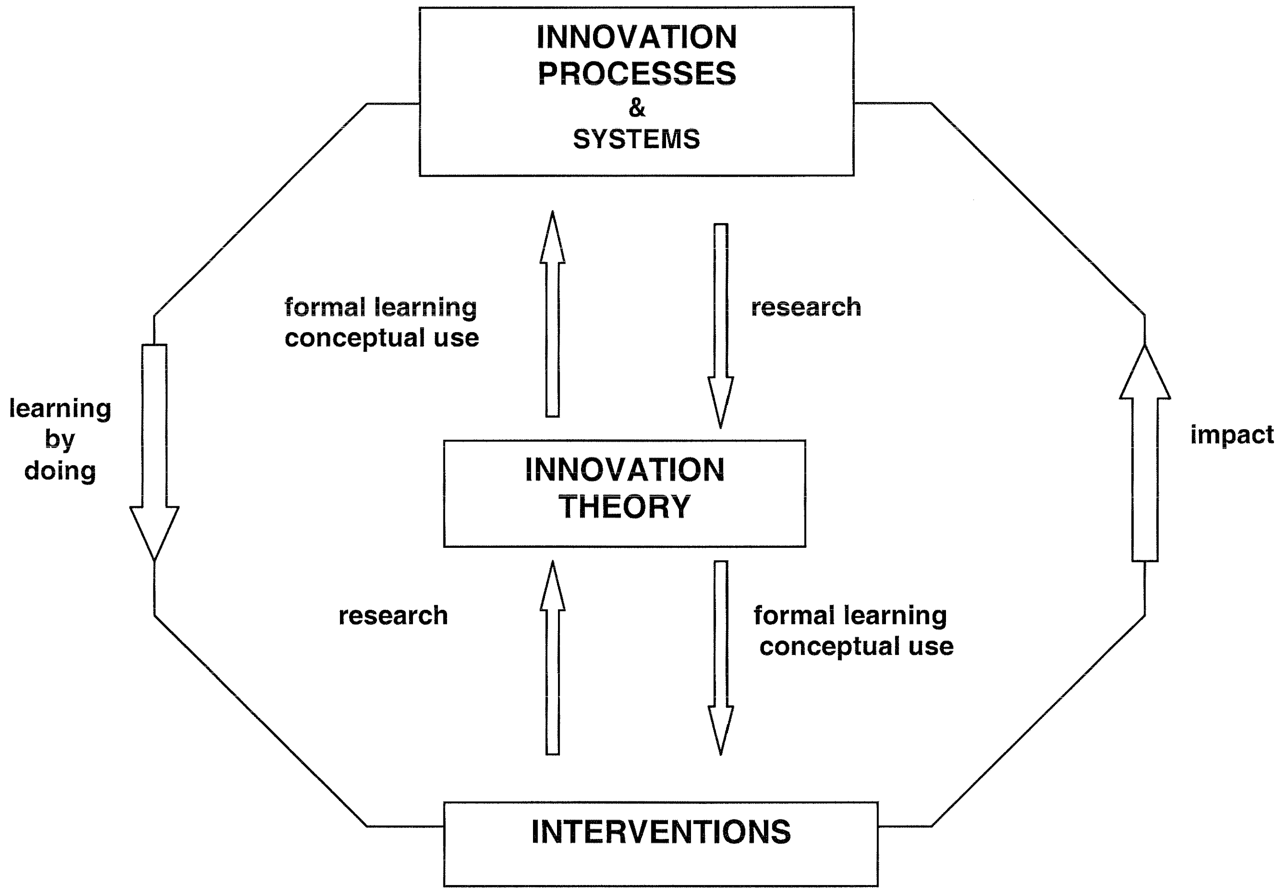
Starting from the co-evolutionary development of innovation practice, -theory and –policy, 5 functions are identified that play a crucial role in the management of present-day innovation processes: (1) management of interfaces, (2) (de-) construction and organising (innovation) systems, (3) providing a platform for learning and experimenting, (4) providing an infrastructure for strategic intelligence and (5) stimulating demand articulation, strategy and vision development. From an analysis of innovation policy instrument portfolios it appears that the already existing instruments can be classified in three categories (financial, diffusion oriented and managerial support) and that they only cover a small part of the 5 'systemic' functions. Furthermore it is concluded that the portfolios are heavily dominated by financial instruments. It is argued that the development of a (relatively) new type of instrument, the *systemic instruments*, should be furthered in order to tune the instrument portfolio better to the needs of actors involved in innovation processes. In order to obtain a better insight into the characteristics of systemic instruments, their success and fail factors, and into strategies for their further development, effectiveness and use a description and first analysis of 4 systemic instruments *avant la letter* is presented. From this suggestions for policy are derived and questions for further research are proposed.

Keywords: Innovation studies, innovation policies, policy instruments, innovation systems, systemic instruments.

1 Introduction

Important developments have been observed over the last three decades in (1) the nature of innovation systems and processes, (2) innovation theory and (3) innovation policies and intervention strategies (Barré et al., 1997, Kuhlmann, 2001a, Lundvall & Borras, 1998, the Economist, 2001, Bartzokas, 2001). These three developments are strongly interlinked. Policies and interventions have an impact on innovation systems and processes from which innovation researchers can learn about the internal dynamics of these processes and systems. While policy makers and other actors learn directly from their interventions by evaluating the results of their efforts (learning by doing, learning by interacting), at the same time they absorb new theoretical insights and translate them into new concepts and instruments[2] (conceptual use and formal learning). In turn this lead to new types of interventions (exhibit 1).

Exhibit 1: **Co-evolution of practice, theory and intervention**



The analysis in this paper focuses on the impact of these three co-evolutionary developments on the instruments used by policy makers and other actors concerned. We have taken the *national innovation system* concept (NIS) as the point of departure for our analysis (exhibit 2). The NIS is defined by Freeman (1987) as:

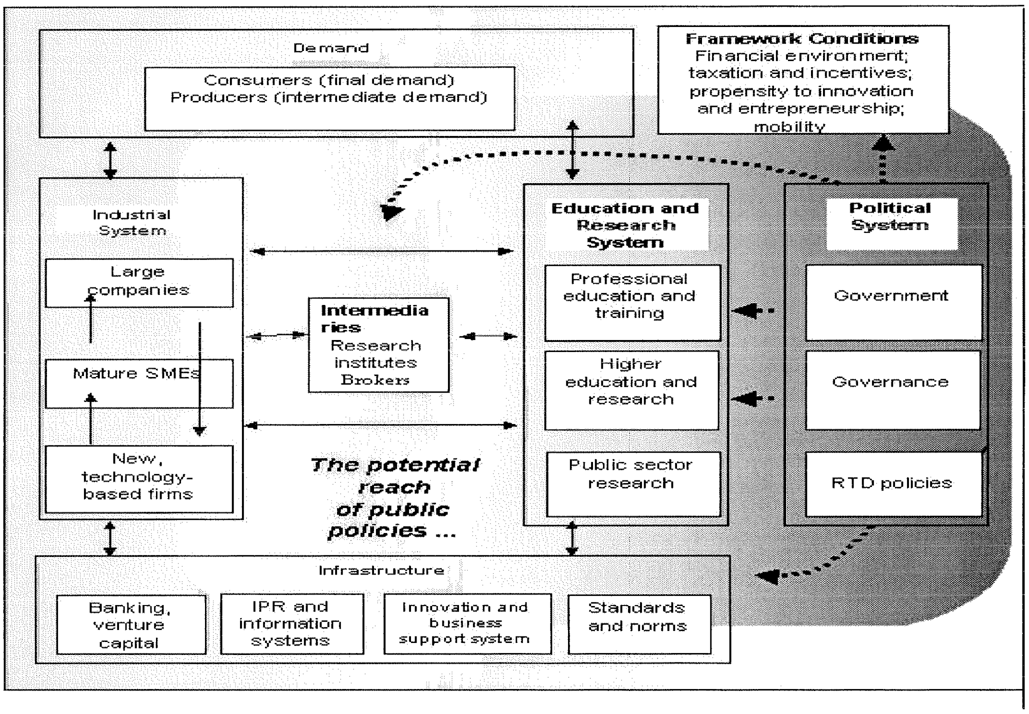
...The network of institutions in public and private sectors whose activities and interconnections initiate, import and diffuse new technologies.

[2] The term 'instruments' is used here in the broad sense, referring to a variety of means used by policy makers and other actors involved to influence innovation processes. Examples: tax schemes, R&D subsidies, mobility schemes, management support programmes, cluster policies, innovation centres and priority programmes.

The main idea behind this 'systems thinking' is that gains from investing in the development of knowledge are to a large extent determined by the way in which knowledge production is organised and embedded in societal and economic processes and systems (Nelson, 1993, Freeman, 1987). The systems approach plays a role at two levels in this paper. Firstly, the growing attention for and awareness of the systems approach must be seen as one of the most important driving forces behind the growing need for more 'systemic' instruments. In this paper systemic instruments play a pivotal role in our analysis of developments in the policy instruments portfolio. Secondly, we use the metaphor of the innovation system as a heuristic framework in analysing the developments in the portfolio.

Exhibit 2: **Innovation System and the reach of public policies**

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



Apart from the well-known financial, diffusion oriented and managerial instruments, a new type of instrument – the so called *systemic instruments* – will be introduced as a result of our analysis. The emergence of these systemic instruments must be seen as a result of the co-evolutionary learning processes mentioned above. Specifically, the rise of systemic instruments is directly related to two major trends: the growing systemic character of innovation processes and the blurring of the boundaries of organisations involved in innovation processes (Gibbons et al., 1994, Smits, 2002).

While in our view the rise of systemic instruments reflects structural changes in intervention strategies, this does not mean that the aforementioned existing instruments have become superfluous. On the contrary, apart from adding new functionalities to the toolkit used by policy makers and other actors willing to intervene in innovation processes, systemic instruments often contribute to an increase in the effectiveness and efficiency and/or reshaping of the 'old' instruments. For instance, the impact of financial instruments aiming to further innovation focusing on stimulating public expenditure on R&D tends to become more intense when instruments that stimulate the diffusion of the results of that R&D are introduced. Similarly, the effectiveness of diffusion instruments will improve by instruments that aim to bridge what Bessant and Rush (1995) call the 'managerial gap' (organisational and management deficiencies hindering the translation of technological competences in successful innovations). It is quite feasible that systemic instruments have a positive impact on managerial instruments that support the development of innovation strategies because these instruments may help to obtain a better view of the context in which the innovating firm has to operate. Furthermore, systemic instruments may help to improve and even reshape existing instruments. The progress of Dutch innovation centres from organisations focused on the transfer of knowledge to consultants endeavouring to bridge the managerial gap is one example of such reshaping. The same accounts for the development of technology assessment from a purely scientific activity, attempting to predict all feasible positive and negative impacts of a new technology, towards a more policy-oriented instrument; an instrument that aims to provide the actors involved in innovation processes with specific, relevant information, and by doing so playing an important role in improving the interface between developers, users and regulatory actors. Both processes of reshaping are manifestations of trends that also underlie the rise of the systemic instruments. In section [4], where we compare the 'new' instruments with the 'old' ones, we go more deeply into the relationships between the various types of instruments. As an illustration in Appendix 1 an analysis is presented of the reshaping of technology assessment from a purely scientific instrument into a far more systemic instrument.

In conclusion, the focus of this paper is not so much on the introduction of a new type of policy instrument, but rather on the actual or necessary changes in the portfolio of innovation policy instruments as a result of the co-evolution of practice, theory and intervention.

2 Research questions and method of approach

Research questions

The principal question of this paper is:

> *What are the consequences of the co-evolution of innovation practice, theory and intervention strategies for the instruments used by policy makers and other relevant actors?*

The following questions will be addressed in particular:

1a. What, over the last three decades, have been the *major trends* in innovation processes, innovation systems and intervention strategies, including governmental innovation policies?
1b What are the *consequences* of these trends for the functions required of policy instruments and for the composition of the policy instruments portfolio?
2a. Which were the (initial) *experiences* with instruments fulfilling (a part of) the functions mentioned in question 1b?
2b. What can be learnt from these experiences in terms of impact, barriers, incentives and best practices?
2c. To what extent can the experiences and *best practices* related to these instruments be imitated by other countries given the specificities of innovation systems and differences regarding the development stage of governmental innovation polices?
3. What could be the *role of national and international governments* in furthering the development and in stimulating and facilitating the use of instruments to fulfil these functions?
4. How can *research* help to further the development and use of these instruments?

Structure

The structure of this paper is as follows. Section 3 presents an analysis of three basic trends in the co-evolution of innovation practice, theory and intervention. In this analysis five functions are identified that play a crucial role in the management of present-day innovation processes. Section 4 analyses the development of the innovation instruments portfolio over the last 25 years. A characterisation of these instruments in terms of *legitimisation, type of knowledge, the nature of the problem addressed, the object and level of intervention, the goal, client and nature (content or process oriented)*, leads to the conclusion that the existing instruments fail to support the five functions adequately. Systemic instruments should be added (to a larger extent) to the instruments portfolio in order to effectively tackle the challenges of contemporary innovation systems and innovation processes. In order to obtain a better insight into the characteristics of systemic instruments, their success and fail factors, and into strategies for their further development, effectiveness and use, section 5 presents a description and (initial) analysis of 4 'systemic instruments *avant la lettre*'. Section 6 concludes the paper by providing an answer to the research questions and by presenting a research agenda aiming to further the development and effectiveness of systemic instruments. In this section, special attention is paid to the role of the European Union in creating the conditions that will be required to carry out the proposed research and support the development and use of systemic instruments.

3 Trends in innovation processes, systems, theory and policies

Introduction

The nature of innovation processes and systems, as well as theoretical insights have changed considerably over the last three decades. In this section we will discuss three major trends and their implications for intervention strategies and policy making that became especially manifest over the past 10 years. This section will conclude with an analysis of the consequences of these changes for intervention and policy instruments.

Trend 1[3]: The end of the linear model

For many years now the linear model of science, research, technology and innovation, together with a view of innovation processes as an autonomous development, was the prevailing perspective. This has changed quite rapidly over the last three decades. Scholars such as Kuhn (1962), Nelson & Winter (1977), Callon (1992), Bijker et al., (1987), Rip (1978), Etzkowitz & Leydesdorff (2000), Ziman (1987; 2001) emphasise that science and innovation based thereon is the result of social and economic processes, and thus – almost per definition – is not a deterministic process. Furthermore, authors like Mowery and Rosenberg, (1978), Rosenberg and Kline (1986), OECD (1992), Rip & Kemp (1998), Gibbons et al., (1984), Freeman and Lundvall (1988) and Schmoch, (2001), point out the numerous and frequent interactions and feedback processes between users and producers in innovation processes. The linear model is further contested by the recent rise of research in innovation in services. Barras (1986) introduced the concept of the reverse product cycle and in doing so turned the linear model completely upside down. Recent research (Den Hertog et al., 1998, Hipp 1999; Den Hertog, 2000, Gallouj, 1996) refines this model further by showing that also in service innovations interactions and feedback play a very important role.
Another body of literature of relevance here focuses on the role of users in innovation processes (von Hippel, 1988, Silverstone & Hirsch, 1992, Grupp, 1992, Smits & Leijten, 1995, Oudshoorn & Pinch, forthcoming). From this literature it becomes clear that users are involved in innovation processes during the design stage as well as during the actual use of innovations. In this context Silverstone & Haddon (1996) introduce the concept of domestication of innovations. They point out the strong interaction between designers and users after the introduction of an innovation on the market leading to (sometimes a whole series of) modifications. The central message of this rapidly growing body of literature is that users will play an increasingly important role in innovation processes. The reason for this being that users want more grip on innovation processes. The producers of innovations on the other hand are interested in broad societal acceptance of innovations, access to tacit knowledge and – induced by the variety of modern technologies such as ICT – increasingly in mobilising the creative potential of users.

The most important consequence of this trend for policy makers is the increasing need to manage interfaces between users and producers of innovations. This management should focus not only on the transfer of knowledge, technologies and technological competence, but also on raising awareness, stimulating demand articulation by providing tailor-made strategic information and bridging gaps between actors with very different backgrounds and institutional positions. In this context Geurts (1993) makes a distinction between four types of gaps respectively between: (i) policy practice and the world of science, (ii) scientific disciplines, (iii) policy makers and managers and those who are managed and (iv) experts and laymen.

Trend 2: The rise of the systems approach

A trend related to the foregoing is the growing influence of the systems perspective. There are many definitions of innovation systems (see also section 1). One which serves the needs of this paper very well was formulated by Metcalfe (1995):

A system of innovation is that set of distinct institutions which jointly and individually contributes to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.

3 Partly trends in the traditional meaning of developments over time, partly developments that already existed but have only recently been recognised as such.

Innovation systems are encompassing, according to a meanwhile widely accepted understanding, the 'biotopes' 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. 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. As 'hybrid systems' (e.g. Kuhlmann, 2001) they represent sections of society which carry far over into other societal areas, e.g. through education, or through entrepreneurial innovation activities and their socio-economic effects: innovation systems have a decisive influence on the modernisation processes of a society.
Starting point of the innovation systems approach is that organisations are not innovating in isolation but in the context of an innovation system (Freeman, 1987, Nelson, 1993, Lundvall, 1992, Barré et al., 1997). As a consequence their performance is dependent on the quality of that system, more in particular on the quality of the subsystems[4] (R&D, users, intermediary and supportive infrastructure) and, maybe even more, on the mutual tuning of these subsystems (Freeman, 1997, Smits 2002). Another consequence of the systems approach is that more and very heterogeneous actors, often at very different levels and operating in various arenas, are involved in (the management of) innovation processes (Kuhlmann et al., 1999). A further characteristic of the systems approach is the concept of 'path dependency'. By this concept the specificity of innovation systems is underlined once more and moreover the concept stresses that systems do have a memory that should be taken into account when studying the dynamics of system development (Rosenberg, 1976; Hollingsworth & Boyer, 1997).
Another trend to be mentioned here concerns the growing *fuzziness* of innovation systems. Starting in the mid-eighties innovation systems develop from systems with discrete, loosely coupled entities into systems with strongly interlinked entities with rather fuzzy boundaries. The shift in the research system from *mode 1 – mode 2* and the social distribution of knowledge production as described by Gibbons et al., (1994), the development of 2nd order knowledge infrastructure (Den Hertog, 2000), the growing number of technology-based strategic alliances between firms (Hagedoorn & Schakenraad, 1990) and the – partly related to the foregoing – radically changing position of the firm (van Rossum, 2000, The Economist, 2001) are illustrations of this trend. More and more has innovation become a network activity (Schmoch et al., 1996, Rotmans, 2000). That was always true for innovations in the public and public-private domain (sustainable development, health, education, transport), but also becomes more true in the private domain.
A last indication of this trend are the first results of the COVOSECO-project[5]. An analysis in nine countries shows a growing need for public private partnerships (PPP) in the area of research, technology and development. The major goal is to reinforce the quality of the national innovation systems by improving the interfaces between the research system and industry. In the study it is concluded that PPPs are an old instrument, but that they are often limited to the short term, one-to-one interaction (mobility, technology transfer) and commercial goals, for instance the commercialisation of university research results (Faroult, 2002). The report stresses that nowadays there is a particular need for PPPs that have a long-term orientation, involve clusters of firms and research organisations and play a role in the organisation of the innovation system and strategy development within the system.

This trend has two important implications for policy makers. The first one is the need to embed innovation policies in a broader socio-economic context. This implies a considerable broadening of the policy domain, better opportunities for tuning and joint action, and a shift from top down to network steering (horizontal policies). The second consequence is even more important. While the more traditional 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*. Jacobsson and Johnson (2000), in an analysis of the innovation systems approach in energy systems, identify the following flaws in the innovation system:

- poorly articulated demand;
- local search processes which miss opportunities elsewhere;
- too weak networks (hindering knowledge transfer);

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4 See also section 4.

5 COVOSECO, from co-operation between to CO-eVOlution of Science and the ECOnomy, is a project commissioned within the framework of the STRATA Programme of the EC DG Research. Covoseco aims at identifying and improving public private partnerships between science and the economy. The main goal of the project is the development of an 'empowerment evaluation tool', a process oriented self-evaluation tool that should help to monitor and improve public private partnerships. Important basis for the development of this tool are studies of the development of public private partnerships in 9 countries: USA, Ireland, Greece, England, Spain, France, Germany, Slovenia and Sweden (Faroult, 2002).

- too strong networks (causing 'lock in', dominance of incumbent actors, no necessary creative destruction and *Neue Kombinationen*);
- 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 the following roles for government:
- support of different designs, safeguard variety, large portfolio of technologies and innovations;
- strengthen linkages, management of interfaces, reinforcement of user-producer relations;
- build new networks (*Neue Kombinationen*) and deconstruct old ones (creative destruction);
- stimulate learning processes;
- raise awareness, stimulate articulation of demand;
- monitor the struggle between proponents of new technologies and incumbents of the old ones;
- stimulate *prime movers;*
- take care of the (very) long time horizon related to institutional change.

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 policy-making arenas. 'State' authorities in (regional, national, transnational) multi-actor arenas of innovation policy play an important, but not a dominant role (Kuhlmann, 2001). In many cases they perform more the function 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 the joint production of consensus. Hence, normative RTD policy rationales (market failure; public goods; ...) normally do not rule the *de facto* behaviour of decision-making actors in innovation 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.

Trend 3: Inherent uncertainty

Innovation is not a matter of optimising performance under neo-classical conditions. Uncertainty is inherent to innovation for several reasons. A very fundamental source of this uncertainty relates to the 'man made' character of innovation; because innovation is the work of man, it can never be predicted (Grupp, 1993, Irvine and Martin, 1989). Furthermore, the systems perspective indicates that many actors from various perspectives are involved in innovation processes. This implies that innovation is a complex process, difficult to comprehend. Actors involved in innovation processes do not possess perfect information and they must function under conditions of bounded rationality (Simon, 1976). Technology does not offer itself as ready-made packages, but far more as opportunities. It is up to users to trace these opportunities, make clear what they mean for them, assessing the implications of implementation and, finally, make a selection and develop plans to make sure that the selected opportunities are indeed turned into successful innovations (Smits et al., 1995). This being said, it will be clear that innovation is not a matter of optimising performance under 'neo classical' conditions but a process of trial and error in which various types of learning (learning by doing, learning by using, learning by interacting and learning on system level) play an important role (Rosenberg, 1982, Barré et al., 1997, Lundvall and Borras, 1998).
The importance of learning is also stressed in the USA study of the previously mentioned Covoseco project. From an analysis of public private partnerships in the USA in the area of research, technology and development it becomes clear that the need for learning is one of the most important driving forces behind the development of PPPs (Shapira, 2002):

Interestingly, the management literature emphasises that the most successful business partnerships and alliances are those where there is a strategic commitment to learning. In the world of PPPs, learning is expressed as a major goal. As the ATP and MEP[6] cases indicate, there is learning in these partnerships over time, and improvements occur. However, it is apparent that other goals related to economic rationalisation and political expectations constrain the commitment to learning too, leading to less than the strategic outcomes originally anticipated.

[6] ATP = Advanced Technology Partnership, MEP = Manufacturing Extension Partnership

One of the most important consequences for policy making is that given the dominant role of uncertainty in innovation processes, a wide variety of instruments is necessary and it is contradictory to the high level of uncertainty to require high effectiveness. As Boekholt et al., (2001)say:

Therefore requiring a high effectiveness of this type of policy, i.e. achieving a high level of its targets, is contradictory to what this type of policy aims to achieve. Decreasing the high threshold for companies and organisations to enter into high risk innovation trajectories is, by definition, a policy domain which brings an expected level of failures. If too stringent effectiveness targets in the short term are required, this could lead to risk aversive public interventions, maybe achieving incremental results in the short term, but little more radical results in the long term. So innovation policy should leave some room for experimentation and calculated failures.

Policy making can basically support the learning processes necessary to cope with this uncertainty in two ways. The first line focuses on a reduction of uncertainty by providing actors with the information they need to develop and implement their strategies. Various strands of strategic intelligence as foresight, technology assessment, evaluation studies and benchmarking try to fulfil these needs. Recent research however shows that the quality of this information could be considerably increased, for instance by linking the various sources of strategic intelligence and by this exploit potential synergy (Kuhlmann et al., 1999), building up an architecture of distributed intelligence for innovation policy making (Kuhlmann 2002). Moreover it appears that this type of information is too often supply driven and not tailored to the specific needs of the various actors (Smits, 2002). The second line aims at providing actors with the instruments, facilities and environments for experimenting and learning. A growing number of so called participative and communicative instruments have been developed and applied over the past decade. The Multi Media Laboratory of the Massachusetts Institute of Technology, consensus development conferences, scenario development workshops as developed for the European Union to stimulate the debate on innovation on sustainable development at regional and local levels (Jacobs, 1993) and tailor made applications of group decision support systems in combination with other interactive instruments allowing for participation of actors with different backgrounds (Mayer, 1997, Geurts, 1993, Bongers, 2000, Dialogic, 1999) may illustrate this. A recent example of such an instrument is the so-called Policy Laboratory. The Policy Laboratory is a facility where the interactive and participatory instruments, as well as the knowledge to apply them, are brought together. It is called a laboratory because an important objective of the policy laboratory is to learn from the application of the instruments in order to improve the instruments or the way in which they are applied, or even to develop new instruments (Smits & Geurts, 1997, Glasbergen & Smits, 2002, see also section 6 and appendix 3).

To conclude: consequences for policy instruments

To conclude we will take a closer look at what these trends demand from the toolkit of policy makers and other actors involved in innovation processes. Given the trends and policy-implications presented in the foregoing, the following five functions should be given more attention when compiling the portfolio of policy instruments:

1. **The management of interfaces**
   This management not only aims at transferring knowledge but also at building bridges and stimulating the debate. Furthermore, the management of interfaces is not limited to bilateral contacts but also focuses on chains, networks and at system level.
2. **Building and organising (innovation) systems**
   Construction (*Neue Kombinationen*) and deconstruction (creative destruction) of (sub) systems, initiate and organise, discourse, alignment, consensus. Also the management of complex systems, prevention of lock-in, identification and facilitation of prime movers and ensuring that all relevant actors are involved, are part of this function.
3. **Providing a platform for learning and experimenting**
   Create conditions for various forms of learning such as: learning by doing, learning by using, learning by interacting and learning at system level (= contribute to the added value of the whole system).
4. **Providing an infrastructure for strategic intelligence**
   Identify sources (TA, Foresight, Evaluation, Bench Marking) build links between sources, improve accessibility for all relevant actors (Clearing house) and stimulate the development of the capacity to produce strategic information tailored to the needs of actors involved.
5. **Stimulating demand articulation, strategy and vision development**
   Stimulate and facilitate the search for possible applications, develop instruments that support discourse, vision and strategy-development.

In the next section we will show that the prevailing instruments, although they sometimes touch on the new demands, do not meet the needs as formulated in the foregoing in a sufficient way. Our conclusion is that we need a new type of instrument which we have labelled the *systemic instrument*. Furthermore we will also discuss in this section how these new instruments relate to already existing instruments and what they imply for the composition of the portfolio.

4 Systemic instruments and the instruments portfolio

Introduction

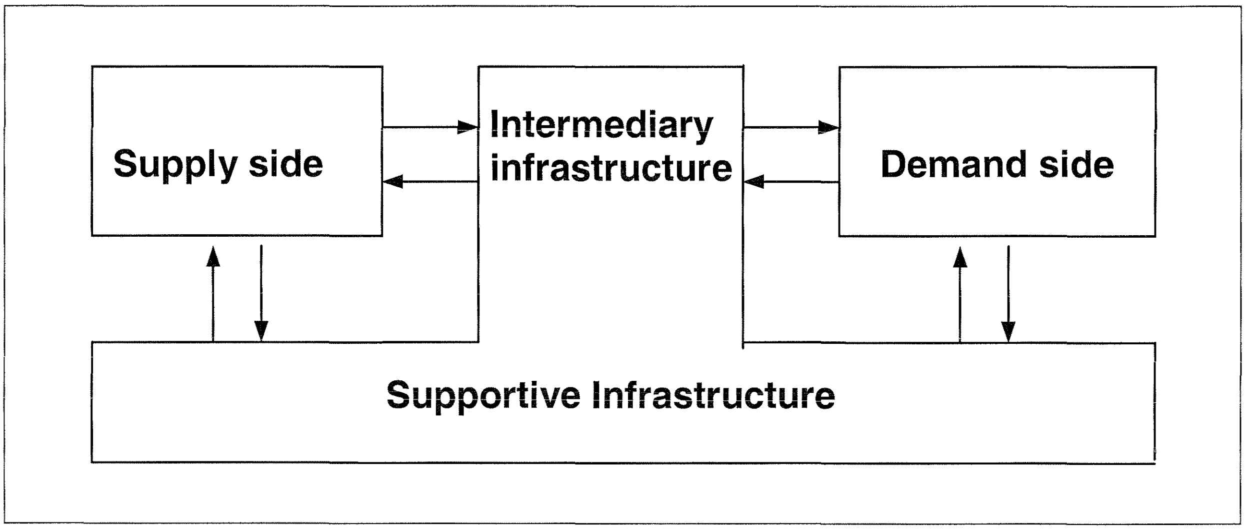
The principal question addressed in this section is to what extent does the instruments portfolio of innovation policy makers meet the demands that result from the co-evolution of practice, theory and intervention (as operationalised in the five functions presented in the previous section). We shall attempt to answer this question by looking into how this portfolio is being developed. In doing so, we focus on policy makers in the OECD countries which have a well-developed knowledge-intensive economy, such as (in the EU) France, Germany, Belgium, the Scandinavian countries, Austria, Ireland, the Netherlands, the UK and (outside the EU) New Zealand, Canada, Australia and the US. It is obvious that there are other nations – also within the context of the EU – that still cannot (as yet) be characterised as being strongly knowledge based. For these countries, e.g. Spain, Portugal, Greece, and many of the pre-accession countries, the systemic instruments debate is not so very relevant since their innovation systems and policies do not yetmatch the actual functions that systemic instruments represent.

We first take a look at how the instruments portfolio has developed by studying the development of innovation policy in the Netherlands over the past 25 years. In this analysis we will see (as can be expected from the co-evolutionary perspective) that the development of these instruments mirrors the changing views on the goals, possibilities and limitations of innovation policy and innovation theory. Although the Netherlands certainly does have some specific characteristics – one of the most important ones in this context being the so-called *Polder Model*[7] - OECD studies and recent evaluations (Boekholt et al., 2001) and analyses (Van der Meulen & Rip, 1998) show that the main trends reflect policy developments in other countries and are certainly in line with the method of approach chosen by the EU and the OECD in this area[8].

The development of innovation policy in the Netherlands

In analysing the development of Dutch innovation policy over the last 25 years we have made use of a simplified diagram of the national innovation system (exhibit 3).

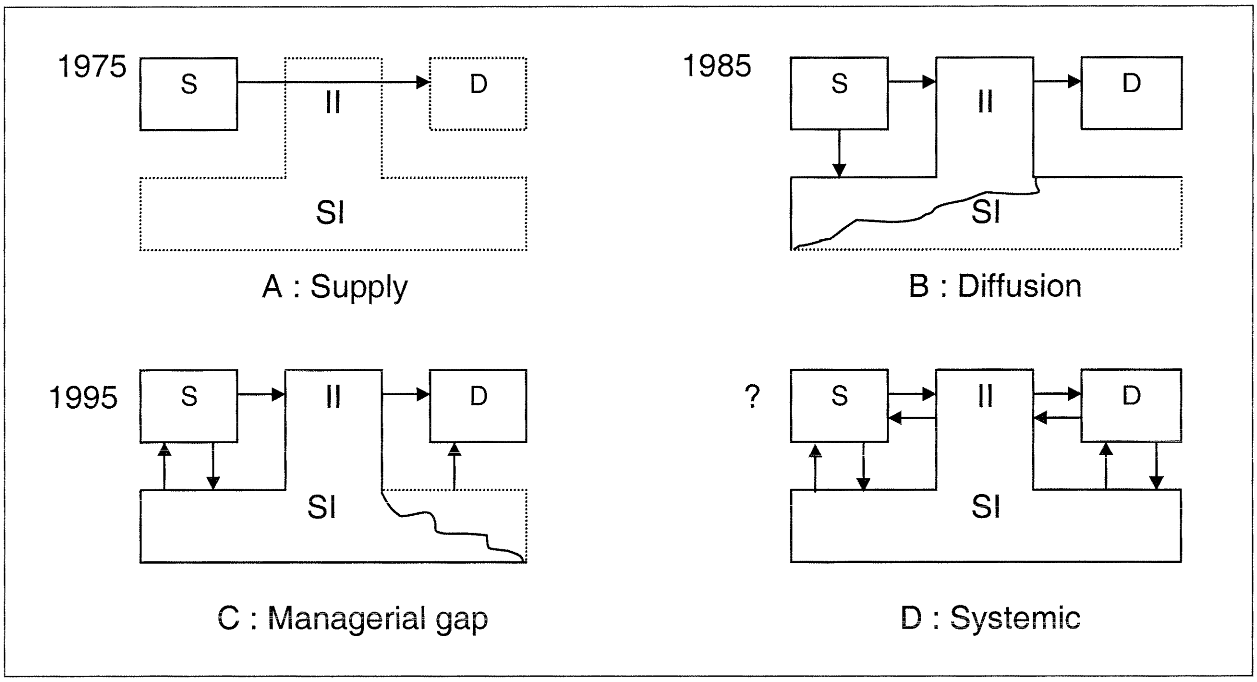
Exhibit 3: **The national innovation system**
Source: Smits 1994



[7] The *Polder Model* refers to the strong consensus tradition in policy making in the Netherlands.
[8] See for instance the OECD's acceptance of the so-called cluster approach initiated in the Netherlands in the mid 90s and can now be regarded as a – potentially – powerful systemic instrument.

There are four components distinguished In this system. First of all there is the *supply side* which covers the production of knowledge; the research system. Universities, public research organisations and industrial laboratories are part of this subsystem. The *demand side* covers consumers, firms, governmental departments and other users of knowledge-based products and services. The third subsystem is the *intermediary infrastructure* comprising institutions, mechanisms and organisations aiming at improving the interface and exchange of knowledge between the supply and the demand side. Technology transfer policies, innovation centres, and also researcher mobility schemes are part of this subsystem. The last subsystem is the *supportive infrastructure*. Educational systems, material and immaterial infrastructures, strategic intelligence, the availability of risk capital, the match between supply and demand on the labour market, the level of management capacities of firms, and the relations between employers and employees are several aspects of this subsystem. Taking this innovation system as the point of departure and looking at Dutch innovation policy over the last 25 years, we see a remarkable development (exhibit 4). It is by no means an exaggeration to state that in the mid-1970s the Netherlands had nothing at all in place that resembled an explicit innovation policy. Although certain elements of such a policy were incorporated in the instruments portfolio of the Ministry of Economic Affairs, the so-called technology development credit 'TOK' being the most prominent example, innovation was not really seen as an issue of any importance. In general terms, science and technology were not even on the agenda. One remarkable exception in this context are the so-called Science Shops. These Science Shops originated in the Netherlands in the early seventies and had the major goal of making university research more accessible to societal groups. It was the intention of the Science Shop movement to improve the democratic level of decision making on science and technology, and at the same time to increase the societal relevance of university research. However, the driving forces behind the Science Shops differed considerably from those behind the emergence of innovation policy towards the end of the seventies and early eighties. The Science Shops developed within the context of the debate on science policy (OECD, 1971) and the struggle of environmentalist groups, students and civil rights movements to realise structural changes in the administrative and institutional systems. Improving the democratic level of decision making and sustainability were key issues in those debates. As became clear from recent research (Gnaiger and Martin, 2001) while since then the Science Shop concept *has* spread over many countries at the same time it must be concluded that these shops only play a marginal role in the strengthening of interfaces in innovation systems. This is in sharp contrast with the impact of innovation policy that started to develop in the late 1970s. The driving force behind the genesis of innovation policy was the economic recession in the second half of the 70s. It gradually became clear that the Dutch economy had gone through a process of restructuring, resulting in the new economic structure no longer implying that competition on prices and wages, but that competition on added value, new or advanced products and services would be central (Advisory Council on Government Policy, 1980). Innovation was thus placed on the political agenda and a first attempt was made to develop innovation policy. This policy (phase A) was strongly supply-oriented and dominated by financial instruments, stimulating R&D by starting up national research programmes in the area of biotechnology, new materials and information technology. Although this policy was successful in reinforcing and rewarding the knowledge infrastructure – which to some extent suffered in the 1970s when science and technology was 'on trial' (as expressed by the OECD in 1978) – the ultimate goal, that of strengthening the competitive power of the Dutch economy, failed to be realized. As Annemieke Roobeek pointed out in her dissertation, 'Beyond the Technology Race. An Analysis of Technology Policy in Seven Industrial Countries', the Netherlands was not the only country facing this problem.

Exhibit 4: **Development of innovation policy in the Netherlands**
Source: Smits 1994



The solution to this problem was sought in strengthening the intermediary infrastructure in order to be better able to ensure that new technologies were not only developed, but that those new technologies also reached the doors of the firms that had to use them for the purpose of developing new products and services (phase B). In the Netherlands this resulted in the development of policy instruments aiming to stimulate the mobility of researchers from academia to private enterprise and in the establishment of a network of eighteen regional innovation centres. The primary goal of these centres was to bridge the gap between the business community and the knowledge infrastructure at regional level. Simultaneously, several measures were taken to tackle the problem of the mismatches on the labour market. This was the first move towards the further development of the intermediary infrastructure (exhibit 3, phase B).
Without doubt, the innovation centres improved the utilisation of new technologies, but in the early 1990s it still became clear that policy could not be restricted to measures that only encouraged the production and diffusion of knowledge. A considerable mismatch between the needs of private firms and the knowledge that was being produced was apparent only too often. A better interaction between the producers and the suppliers of knowledge was essential to be able to cope with this problem. This awareness was the start of the next phase in Dutch innovation policy: the user oriented approach. The so called cluster approach, encouraging large companies, small and medium sized enterprises and knowledge organisations to organise themselves in networks, thus making it possible to exchange information in good time and in such a way to bring the production and use of knowledge more into line, is one of the most prominent examples of a policy instrument introduced in this phase (exhibit 3, phase C). This approach, more in particular the cluster policy, was so promising that it was adopted by many OECD countries (OECD, 1999, 2001)[9]. In phase C, it was not only the interfaces between the users and the producers that were improved, but the supportive infrastructure was also expanded by introducing new and/or improved forms of strategic intelligence, more advanced risk capital schemes, a high-level electronic infrastructure, and other conditions that facilitated innovation in networks and systems.

To summarise, over the last 25 years Dutch innovation policy gradually took into account all the various compartments of the innovation system *and* (most of) the associated mutual relations. In phase A the portfolio was heavily dominated by financial instruments (subsidies, tax schemes). In phase B, the diffusion oriented phase, diffusion instruments (transfer schemes, innovation centres) were added to the portfolio. Phase C saw the addition of instruments to support companies at an organisational level in innovation processes (management advice and support) and instruments that enhanced the interface between users and producers in both directions

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9 See also section 5 for an analytical description of the cluster approach.

(the cluster approach). The trend towards instruments that help companies not only to absorb new technologies, but also to teach them how to turn them into new and successful products and services, was described by Bessant and Rush in their article 'Building bridges for innovation: the role of consultants in technology transfer', (Bessant and Rush, 1995) . In this article the point is made that innovation does not stop at the point when a new technology is adopted by the potential user. Bessant and Rush (1995):

..Often there is the implicit assumption that the point at which adoption takes place is the end point of the innovation process. Yet experience suggests that simply possessing a technological resource is no guarantee of its effective use; building technological competence requires a learning process to absorb and optimise the technology. The implication for policy support is that it should cover the post adoption period as well as promote or facilitate adoption.

A direct consequence of this observation is the development of policy instruments that focus on what Bessant and Rush call "bridging the *managerial gap*". In our scheme they constitute an important part of the instruments that were added to the portfolio in phase C.
Focusing more on mediation between the science system and society in general, Van der Meulen and Rip concentrate on the growing importance of what they call the "intermediary level" (Van der Meulen & Rip, 1998). In their analysis of the Dutch research system they point out the growing number of intermediary organisations and institutions such as the Association of Universities in the Netherlands (VSNU), Sectoral Advisory Councils on Research, Priority Programmes, Foresight Exercises and Technological Top Institutes that play a role in the mediation process between science and society. This mediation process has only a few of the characteristics of the old top-down steering paradigm. As an alternative Van der Meulen and Rip speak of "heterogeneous aggregation" (Van der Meulen & Rip, 1998):

Such aggregation of individual opinions and experiences into a repertoire and an agenda at the collective level is heterogeneous: different kinds of sources and considerations are combined and the process is structured through ongoing interactions, meetings that occur for other reasons, as well as intentional agenda building. Such processes have become important to sustain intermediary level bodies.

From the above description it will be clear that this type of mediation comes quite close to the functions the systemic instruments are intended to fulfil. Although these processes and organisations are especially perceptible in the Netherlands – with its longstanding tradition of consensus development – Van der Meulen and Rip make the point that this trend is also visible in other countries (van der Meulen & Rip, 1998):

There are two overlapping dynamics: one, where horizontal linkages between basic research and industry, non-profit organization, and social groups are becoming more important in their own right; and the other, where government is retreating from its role as both source of policy and its executive. These two movements are quite general: it happens in all sectors, and it happens in other countries than the Netherlands.

To conclude, the direction in which the development is heading is clear: from supply-oriented and one-to-one interactions towards demand-orientation and a systemic approach. In consequence, not only the *type of policy* concept changed from being supply-driven towards being user-oriented, but also the *types of instruments* used. While the more-or-less ideal 'systemic' phase D has not yet been realised by far, awareness of the five 'systemic' functions (introduced in section 3) is growing and in some cases early experiments with instruments covering these functions are developing. A number of these pioneers will be described and analysed in section 5. However, having said that, recent evaluations also show that the Dutch innovation policy portfolio, as well as that of many other countries, is still heavily dominated by financial instruments. In their comparative analysis of the innovation policy instrument portfolios of nine countries, Boekholt et al., conclude (Boekholt et al., 2001)[10]:

The number of industry oriented innovation policy instruments available in the Netherlands has decreased following a deliberate government decision to streamline the policy portfolio, which was quite extensive beforehand. In relation to most benchmark countries the number of instruments is therefore modest. The key problems that Dutch policy tries to address are:

- *In terms of business R&D expenditures the Netherlands has a relatively weak international position. Recent increases in the R&D intensity notwithstanding, the level remains low in an international perspective*
- *The innovativeness of Dutch companies is not very satisfactory in international terms*

10 Other countries covered in this analysis are: Australia, Canada, US, New Zealand, Finland, France, UK, Norway.

- *The interaction between the business sector and public R&D (universities, research organisations) is not optimal and can be intensified*

The following exhibit shows the policy mix matrix for the Netherlands. It shows both the distribution (in %) of the total budget for firm-oriented technology support across various objectives and delivery mechanisms, and the number of instruments in each cell (in parentheses).

The Dutch policy mix, 2000[11]

	Support of R&D	Measures addressing the mismatches in (risk) capital markets	Improving absorptive capacity	R&D co-operation	Knowledge diffusion	Framework conditions for high-tech starters	Human Mobility	Improving exploitation of public knowledge	Total per delivery mechanism
Tax facilities	54 (1)								54
Subsidy Schemes				18 (2)	1 (1)			2 (1)	22
Credit & Loans		10 (1)							10
Brokerage and bridging institutions			5 (1)	5 (1)	1 (1)				10
Integrated packages						3 (2)			3
Total per policy objective	54	10	5	23	2	3		2	100

The relatively high share of expenditure for the generic tax incentive scheme (WBSO) is apparent. Another immediate conclusion is that there are relatively few mechanisms geared towards human mobility and improving exploitation of public knowledge. Subsidy schemes for individual firms are not provided anymore, only those projects with a collaborative character are funded. This has been decided deliberately in order to address another problem in the system: little interaction between actors, particularly industry and research organisations.

And, including the other countries in the analysis, Boekholt et al., continue:

If we look at the current policy mix in the benchmark countries we see that supporting R&D in individual companies is still the major objective of innovation policies in many countries.

In other words, although there seem to be strong indications that policy makers are constantly becoming more aware of the necessity to include systemic instruments in the portfolio, systemic instruments have always been heavily under-represented in the portfolio to date.

Changes in the policy portfolio in Europe and the US

Other studies have also been conducted on the development of innovation policies and instruments which show similar portfolio developments. Bozeman, in his analysis of the US innovation policy, relates the differences in innovation policy concepts and instruments to differences in legitimisation. He distinguishes between three types of legitimisation: market failure, mission orientation and 'co-operative technology'. In exhibit 5 he relates legitimisation to policy concepts. It is apparent from this that in the 1990s mission-oriented and 'co-operative policies' that require more systemic instruments are given more attention. Although according to Bozeman 'co-operative technology' alone was pivotal in the US for 2 years, other research (e.g. Branscom & Florida, 1999, Shapira, 2002) shows quite clearly that policies with unmistakable systemic elements did not disappear after 1994.

[11] Only industry-related instruments are taken into account. Numbers relate to percentages. Numbers between brackets equal the number of instruments in the specific category.

Exhibit 5: **Three competing technology policy models in the US**
Source: Bozeman 2000

Market failure	Mission	Cooperative technology
Core assumptions (1) Markets are the most efficient allocator of information and technology. (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. (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. (3) Government should not compete with private sector in innovation and technology. But a government or university R&D role is a complement.	(1) Markets are not always the most efficient route to innovation and economic growth. (2) Global economy requires more centralized planning and broader support for civilian technology development. (3) Government laboratories and universities can play a role in developing technology, especially pre-competitive technology, for use in the private sector.
Peak influence Highly influential during all periods.	1945-1965; 1992-present.	1992-1994
Policy examples 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 Neo-classical economics.	Traditional liberal governance with broad definition of government role.	Industrial policy theory, regional economic development theory.

Focusing on European approaches, Rothwell & Dodgson (1992) present an analysis of the historical development of innovation policies (exhibit 6), broadly corresponding with Bozeman's three paradigms: starting from the rather separated spheres of science policy (related to the market failure paradigm) and industrial policy (the mission paradigm) of the 1950s and 1960s, the rationale that had been dominant since the 1980s shifted to a growing inter-departmental cooperation, accompanied by a stronger orientation towards innovation, including a considerably strengthened regional and (within the EU) transnational dimension, i.e. towards initiatives following mainly the cooperative policy paradigm, oriented at counteracting systemic failures. This analysis also makes it quite clear that instruments with systemic features become more popular. However, at the same time it must be concluded that the development of this type of instrument is still in its infancy.

Exhibit 6: **Evolution of public research and technology development policies**
Source: Rothwell & Dodgson, 1992

1950s and 1960s	*Science Policy* - Scientific education - University research - Basic research in government laboratories	*Industrial Policy* - Grants for R&D - Equipment grants - Industrial restructuring - Support for collective industrial research - Technical education and training	*Firm Size Emphasis* - Emphasis on large firms and industrial agglomeration - Creating national 'flagship' companies - Public R&D funds go mainly to large companies - Paucity of venture capital
	LITTLE COORDINATION OR ACTIVE COLLABORATION BETWEEN SCIENCE POLICY MAKERS AND INDUSTRIAL POLICY MAKERS		
Mid-1970s to early 1980s	As above - Some concern over lack of university-industry linkages	*Innovation Policy* - Grants for innovation - Involving collective research institutes in product development - Innovation-stimulating public procurement	- Increasing interest in small and medium sized enterprises (SMEs) - Many measures introduced to support innovation in SMEs - Continuing paucity of venture capital
	INCREASING INTERDEPARTMENTAL COORDINATION		
Early-1980s to date	- Increased emphasis on stimulating university-industry linkages - Increased emphasis on 'strategic' research in universities	*Technology Policy* - Selection and support of generic technologies - Growth in European policies of collaboration in pre-competitive research - Emphasis on inter-company collaboration	- Emphasis on the creation of new technology-based firms - Growing availability of venture capital
	INTERDEPARTMENTAL INITIATIVES GROWING INTEREST IN ACCOUNTABILITY AND IN MEASURES FOR EVALUATING THE EFFECTIVENESS OF PUBLIC R&D POLICIES INCREASING CONCERN OVER GROWING REGIONAL ECONOMIC DISPARITIES. NATIONAL AND LOCAL GOVERNMENT INITIATIVES TO ENHANCE THE R&D POTENTIAL OF THE LESS DEVELOPED REGIONS: ACCELERATED ESTABLISHMENT OF REGIONAL TECHNOLOGY INFRASTRUCTURES. EG SCIENCE PARKS. TECHNOPOLES. INNOVATION CENTRES		

A further indication of this trend can be found in the work of Meyer Krahmer and Kuntze (1992). In their '*Bestandsaufnahme der Forschungs und Technologipolitik*' (Inventarisation of Research and Technology Policy) they present a table in which they summarize the policy instruments in use in Germany in the early 1990s. It is also evident from this table (exhibit 7) that while instruments with 'systemic' elements (in italics) are already perceptible, they still only comprise a small part of the instrument portfolio.

Exhibit 7: **Instruments of Public RTD Policy**
Source: Meyer-Krahmer/Kuntze 1992

<table>
<tr><th>Instruments in a narrow sense</th><th>Instruments in a broader sense</th></tr>
<tr><td rowspan="2">1. Institutional funding
• National Research Centres
• Research Councils (in Germany DFG; Max Planck Society)
• Applied Research and Techn. Development Organisations (in Germany e.g. Fraunhofer Society)
• Universities and other Higher Education Institutions
• Others</td><td>4. Public demand and procurement</td></tr>
<tr><td rowspan="2">5. Corporatist measures

• Long-term visions; technology foresight
• Technology assessment
• Awareness initiatives</td></tr>
<tr><td rowspan="2">2. Financial incentives
• Indirect promotion programmes (e.g. CIM)
• Technology promotion programmes (cooperative R&D projects)
• Risk capital</td></tr>
<tr><td>6. (Continuing) education; training</td></tr>
<tr><td>3. Other innovation infrastructure and technology transfer mechanisms
• Information and consultancy for SMEs
• Demonstration centres
• Technology centres
• Cooperation, networks, people</td><td>7. Public policy
• Competition policy
• (De-) Regulation
• Public stimulation of private demand</td></tr>
</table>

After the development of public private partnerships (PPP) between the world of science and the economy, the need for more systemic instruments can also be seen from the Covoseco study. The first indication is the plea for more PPPs with a long-term strategic orientation, in which more actors are involved, and which might have an organising potential in the national innovation system (see also section 3). The second indication is the conclusion from almost all the countries covered in the Covoseco study that up to now the evaluation of PPPs has hardly been organised on a structural basis, and that there is a need to improve the evaluative function. It was stated specifically in the German case study (Moon, 2002):

Concerning the last point on the evaluation in the German research system, we can raise the question how to evaluate PPP as innovation networks supported by public funds. PPP can have a positive outcome only when actors are open in their dealings with each other, are prepared, as players 'on the team', to input their knowledge and listen to what others have to say. The complex process nature of PPP requires a sophisticated analysis of the evaluation principles and tools available: PPP at national level or by the Länder at regional level should be evaluated using methods that correspond to this recent understanding of innovation processes. Evaluation methods should be focused on the innovation process itself, and evaluators should become agents within the process – so that evaluation becomes an integral part of the innovation process.

Worded differently: the evaluation function should be organised in the form of a pro-active process as an integral part of the innovation system, playing an important role in providing feedback to researchers, innovators and users. Formulated in this way, the evaluation function is to all intents and purposes characteristic of a systemic instrument that fulfils a role in managing interfaces and facilitating the learning process.

The last piece of evidence to back up our conclusion (while there certainly is an awareness of the need for systemic instruments, that awareness is lacking in daily practice) is to be found on the website of the EU Trend

Chart. This website presents an up-to-date overview of the innovation policy instruments in use in all EU and pre-accession countries. Exhibit 8, which is based on information from this website, shows the frequency of various policy instruments, classifying them in one of four categories: financial, diffusion, managerial, systemic.

Exhibit 8: **Innovation policy instruments in EU and pre-accession countries**
Source: www.trendchart.cordis.lu, February 2002.

Type of instrument	Specific instrument (frequency)
Financial	Financing Taxation (14) Strengthening company research (119) **Start up technology based companies[12](92)**
Diffusion	**Mobility (51)** **Absorption technologies by SMEs (120)**
Managerial	**Mobility (51)** Innovation and management (69) **Start up technology based companies (92)** Absorption technologies by SMEs (120) Strategy, vision of R&D (64)
Systemic	*Dynamic:* Raising public awareness (49) Promotion of clustering and cooperation for innovation (59) Cooperation research, universities, companies (162) *Static (infrastructure):* Public authorities (23) Competition (10) Protection of IPR (49) Administrative simplification (26) Legal and regulatory environment (16) Education and training (55)

It will be clear that it is difficult to interpret the figures shown in exhibit 8 correctly. Taking the Netherlands as an example, it is unrealistic to compare instruments such as the WBSO[13] tax facility (absorbing 54% of the total budget (ca € 330 million)) with the Technology and Society instrument, which is hardly worth 500,000 €. Although exhibit 8 does lead to the conclusion that systemic instruments apparently have appeared on the scene, they still are in their infancy and are under-represented in the portfolio. If we take a closer look at the category of systemic instruments, we see that 179 instruments can be classified as 'infra-structural' and as such contribute very little to the five functions introduced in section 3. The majority of the dynamic instruments belong to the very traditional categories which are more-or-less uni-directional (raising public awareness) or aim to achieve one-to-one relationships (university-industry co-operation). The category of 'Promotion of clustering and co-operation for innovation' is the only one that addresses all five functions. As said earlier, cluster policies can be

12 Instruments in bold print are contained in more than one category.

13 WBSO = *Wet Bevordering Speur- en Ontwikkelingswerk* (Research and Development Allowance).

regarded as one of the pioneering systemic instruments. In section 5 these will be described and analysed further. However, we are still not certain whether we are dealing with 'real' systemic instruments with regard to this category. Public private partnerships can be seen as an important category of clusters. The Covoseco study does however make it clear that many of the PPPs are somewhat short-term oriented and limited to one-to-one interaction (Faroult, 2002). This aspect of what is presented under the heading 'clusters' cannot really be considered as belonging to the category of systemic instruments.

In conclusion, although it would seem that there are strong indications that policy makers are constantly becoming more aware of the necessity to include systemic instruments in the portfolio, these systemic instruments are still seriously under-represented in the portfolio to date.

To conclude: four types of policy instruments

From the foregoing it becomes clear that, in line with the historical development of innovation practice, theory and intervention, we can classify innovation policy instruments into four categories. Three of them are already more or less adequately represented (financial, diffusion, managerial), the fourth category, that of systemic instruments, is under-represented in the portfolio. The main reason being the observation that the first three types of instruments are only partly able to cope with the trends analysed in the previous section. They still take the individual organisation, usually a company, as the unit of analysis, hardly play a role as system builder and system organiser, fail to pay much attention to learning processes, platforms for experimentation, customised strategic intelligence, and most of the time they focus more on the private sector and far less on the public sector and public-private alliances.
In order to clarify the differences we have classified them in two tables. The first table compares the instruments' major characteristics; the second compares the functions.

Table 1: **Four types of policy instruments**

	LEGITIMATION		**TYPE OF KNOWLEDGE**				**SYSTEM LEVEL**[14]		**TYPE OF SUPPORT**[15]		**NATURE OF PROBLEM**	
	Market failures[16]	**System failures**	**β**	**γ**	**βγ**	**Tacit?**	**Organisation**	**System**	**Organisation**	**System**	**Operational**	**Strategic**
Financial	++					not relevant	1-to-1 private		++		++	
Diffusion	++	+	++		+	not relevant	1-to-1 private		++	+	++	
Managerial	++	+		++		formal tacit	1-to-1 public private		++		++	+
Systemic	+	++	+	+	++	formal tacit	1-to-1 public private public& private	system public private public& private	+	++	+	+++

The instruments are characterized in terms of goal, client, content, process and system in table 2. The 'shaded' terms are linked to the five functions mentioned in the foregoing. It shows how the systemic instruments relate to the other types of instruments and what they add to the instrument portfolio. As we can see, financial, diffusion and managerial instruments only contribute marginally to the functions. By this, it also becomes clear that the four types are not mutually exclusive. Diffusion types of instruments, such as innovation centres, are also involved in managerial support, and managerial instruments also deal with strategic questions and systemic instruments with operational issues and individual organisations.

14 System level: is the client an organisation or a network, cluster or system?
15 Type of support: support limited to a single organisation or serving more actors in the system?
16 See Van Dijk & Van Hulst (1988) for a discussion on the market failures that legitimate government intervention in innovation processes.

Table 2: **Functions of policy instruments**

	PRIMARY GOAL	CLIENT	CONTENT	PROCESS	SYSTEM
Financial	Stimulating R&D	One to one Private firm	R&D subsidy	-	-
Diffusion	Transfer of knowledge and/or technological competence	One to one; Private firm (Public institution)	Science subjects; Formal	Limited to specific technical project	-
Managerial gap	Support running a business	One to one One to few (co-makerships) Private firm	Social science; Formal; Tacit	Limited to specific consultancy project; Demand articulation; Strategy development	Organising small chains and clusters; Mgt interfaces
Systemic	Facilitating change	Chains; Networks; Systems;	Science, social sciences; Formal; Tacit; Strategic Intelligence	Mgt complex projects; Strategy & vision development; Demand articulation; Stimulate learning; Stimulate experimenting	System organiser; System builder; Mgt interfaces; Identifying, mobilising, involving users; Guarding democratic content; Developing infrastructure strategic intelligence

As will become clear from section 5, the pioneers of systemic instruments are developing in some areas already. Section 5 will also set out examples of these instruments and – as far as is possible within the context of this paper – analyse them. From this analysis it appears that these instruments are the result of the co-evolutionary process we mentioned earlier. It is shown that it is not the intention for them to 'take over' the role of the other instruments, but rather try to complement the other instruments and thus achieve a better balance in the portfolio. In doing so, they often improve or even reshape already existing instruments.

5 Systemic instruments: four cases as an illustration and source of inspiration for further learning

Introduction

The goal of this section is to describe and analyse a few of the already existing systemic instruments and to explain what we can learn from the initial experiences with using them. The analysis is biased in two ways. The portfolio of instruments is heavily dominated by Dutch – and to a lesser extent – German instruments, and the evaluation is not complete. This was not feasible within the framework of this paper and in many cases it is also not possible since the majority of the instruments have only been recently introduced. Consequently, for most of the instruments there is little information available as to their performance as yet. In this section we will describe the following five systemic instruments:

- Transformation of the NRLO (Dutch Council for Agricultural Research) into the Innovation Network Green Space and Agricultural Cluster
- Sustainable Technological Development Program
- Cluster approach
- *Futur* program

We will do so as follows:

1. **Introduction**
   History, direct cause, *raison d'être*, initiator, goals (in relation to various actors)
2. **Context**
   'Problem definition' including the 'social map', institutional setting (organisations, levels, arenas, actors...), past attempts to tackle the problem, what instrument is supposed to help find the solution, what is new, ...
3. **Description of the instrument and its function(s)**
   A brief description of the instrument in terms of input, artefacts, routines, output/function, ...
4. **Implementation process**
   How is the instrument used, the phases in the implementation process, sub-goals, ...
5. **Relationship with other instruments in the portfolio**
   Complementary, improving effectiveness, re-shaping, ...
6. **Evaluative questions**
   - contribution to the five functions as specified in section 3;
   - effectiveness, impact;
   - efficiency, price/quality ratio;
   - barriers and incentives;
   - role of government at various levels;
   - suggestions for improvement.

As a summary, the instruments are characterised at the end by using the format of table 1 and 2 from section 4.

Case 1: Transformation of the NRLO (Dutch Council for Agricultural Research) into the Innovation Network Rural Areas and Agricultural Systems[17]

1. Introduction

The NRLO is a Sectoral Advisory Council on Research (SC). The goal of these sectoral councils (SC) is to formulate options and priorities for research in their sector in the medium and long term on the basis of a thorough exploration of scientific and societal trends and developments. If necessary, SCs translate these results into a research programme outline.
More in particular, these SCs are of importance for government because they:

- articulate the demand for research in the medium and long term;
- formulate priorities on the basis of tripartite (users of research, government representatives, researchers) deliberations;
- if necessary, suggest adaptations in the knowledge infrastructure;
- programme research in areas prioritised by government;
- formulate from time to time an independent and all encompassing view as to the direction, content, efficiency/cohesion of research in their area.

Other characteristics of SCs are:

- multi-disciplinary;
- strong links with users and researchers;
- focus on strategic research issues;
- impact on the basis of the development of shared visions and ambitions, other than by allocating resources.

These were proposed and developed in two white papers published by the Dutch Minister for Science Policy: 'Innovation' (1974) and 'Innovation. Government policy concerning technological innovation in Dutch society' (1979). SCs are based on the Framework law on SCs from 1987. Today, there are SCs in four areas:

- agriculture (NRLO, Nationale Raad voor Landbouwkundig Onderzoek);
- co-operation with third world countries (RAWOO, Raad van Advies voor Wetenschappelijk Onderzoek in het kader van de Ontwikkelingssamenwerking);
- health (RGO, Raad voor GezondheidsOnderzoek);
- spatial planning, environment, sustainable development (RMNO, Raad voor Ruimte, Milieu en Natuur Onderzoek).

The SCs cooperate in the Committee for deliberation of SC's research and development, the COS. The COS plays an important role in furthering the methods and instruments used by the councils.
SCs are of importance here because they play an important role in strengthening the knowledge user-producer interface in innovation systems. Furthermore, the NRLO is of special importance because this council recently shifted its focus (more so then in the past) to innovations in networks, especially to the advancement of system innovations[18]. To illustrate this shift, the NRLO changed its name into: Innovation Network Rural Areas and Agricultural Systems (abbreviation: Innovation Network)). This 'new' SC was established in the middle of the year 2000. (The typical SC tasks are only a small part of the Innovation Network activities.)

2. Context

The reason for NRLO's recent change in focus and the shift towards the Innovation Network is twofold. First of all there is the structural change the agricultural system in the Netherlands is going through. This process already started in the early 1990s (some people even claim it started in the 1980s) and is leading to tremendous changes

[17] Special thanks to Jan de Wilt for his useful comments on earlier versions of this case study.
[18] Elements of system innovations:

- long-term horizon
- changes in relationships among stakeholders
- co-operation between researchers, experts and innovators in terms of their needs
- public-private co-operation in terms of needs
- multidisciplinary and trans-disciplinary (arts subjects, science subjects and the social sciences)
- can lead to new rules and laws
- cross borders and sectors (multi-domain)

in the Dutch agricultural sector and the associated knowledge infrastructure. In a nutshell: the system must transform from a system based on mass production[19], producing numerous detrimental (environmental) effects (on the environment, animal health and welfare, the landscape) into a system geared to the production of specialties, integrating economical, ecological, ethical, spatial and social values. This development is a major challenge for the researchers, producers and users of agricultural products. Firstly, they have to manage a very complex transition process, and secondly because of the integration of different values and the growing inter-linkages among the actors involved and thus innovation becomes more of a systemic act.
The second driving force behind the NRLO's change in approach is the acknowledgment of the NRLO as a foresight organisation over the period 1995-1999; the evaluation was a positive one. More specifically, the interactive and participatory approach, the consequent use of the interaction model between three domains that a) generate knowledge, b) develop technology and skills and c) lead to innovation, the contribution to opening up the somewhat closed agricultural system, flexibility, the learning approach and the contribution to vision and strategy development of the actors involved, were assessed positively. Apart from these positive results, another important issue for improvement came to the fore: implementation of the results of exploratory studies and other initiatives appeared to be rather weak. The evaluation committee recommended that this problem be solved by placing more emphasis on system innovations and network building for the joint development of ideas, strategies and initiatives, and by stimulating diffusion and implementation (Evaluation Committee NRLO, 1999, Kuijer, 1999). In order to effectuate these recommendations a task force was established which was given the assignment of developing a business plan for the Innovation Network.

3. Description of the instrument and its function(s)
&
4. The implementation process

As is evident from the foregoing, the Innovation Network has not had much time to prove itself[20]. Hence we intend to illustrate the process by referring to the business plan (Task Force Business plan Innovation Network, 2000, abbreviated as TF).
In this Task Force's report, the Innovation Network is positioned as the forum where actors from government, knowledge institutions, societal organisations and private businesses come together because they realise that the future offers new opportunities and that the present solutions are no longer adequate to meet the innovation challenges of the future. With the Innovation Network they find the stimulus, the intellectual power and the co-players to realise new types of innovation and cooperation.
Other characteristics of the Innovation Network:

- supported by all relevant actors;
- free port, breeding ground for new ideas and institutions;
- initiating, flexible, adequate process management;
- based on high quality strategic intelligence (foresight).

Important *starting points* for the Innovation Network are the need to contribute to a more sustainable development, a high level of urgency rapid change, the awareness of creating *Neue Kombinationen* and a new, co-operative culture, are at the roots of innovation.
Given this positioning, characteristics and starting points, the TF formulated the *mission* of Innovation Network as: "... to further a vital and sustainable development of the national and international agricultural sector and rural areas aimed at the improvement of the quality of living of the (inter-) national citizen and consumer and the vitality of eco-systems".
The *major route* to realising this mission runs via the stimulation of system innovations
by carrying out foresight, building networks (for development, diffusion and implementation) and the development of instruments and working methods enabling actors to jointly identify, develop and implement (learning by doing) innovative opportunities. The major outputs envisaged from foresight activities are:

- strategy development and action;
- contributions towards new networks;
- broadly supported strategies;
- starting points for system innovations;

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19 The Dutch agricultural system has for years been one of the most successful in the world. Although the Netherlands is one of the smallest countries of the world it is still the third largest exporter of agricultural products (after the US and France). The high knowledge intensity of this sector is one of the most important factors behind this remarkable achievement.

20 This is not the major problem as it may seem because – although the working method of this research council has changed quite considerably – many approaches, methods and procedures and the instruments used remained unchanged or were marginally adapted and/or used in a different context.

- unexpected encounters;
- scenarios;
- the identification of white spots in knowledge;

To support system innovations Innovation Network will develop and apply a *structured process.* Major steps in this process:

- a conceptual phase, in which ideas for exploratory studies and system innovations are taken stock of by way of a joint search process;
- the composition of a portfolio of relevant themes for exploratory studies and system innovations, and keeping it up to date;
- the creation of support and commitment;
- choosing the method of approach/working method;
- creating the organisational, institutional and financial conditions required for the (execution and guidance of) studies and system innovations;
- the involvement of external expertise (intellectual and process);
- evaluating and consolidating the results;
- actively diffusing the results to all actors involved;
- translating the results into possible initiatives for system innovations of relevant players within their own system.

The *criteria for success* of the Innovation Network:

- renowned centre of excellence;
- best practice in an international context;
- the development of operational criteria for sustainable development;
- an effective working method;
- measurable growth of innovation networks in the agricultural sector for the next five years;
- providing a platform for experimentation and learning.

In conclusion, the *organisational structure* of Innovation Network looks as follows:

- an independent Sector Council[21];
- five year funding;
- board: independent, 9 members, also people from outside the sector;
- bureau: director, 8 senior members of staff, secretariat;
- budget: € 1 million for the bureau, € 3-4 million for activities;
- several network days will be organised each year;
- start: mid-2000.

An example of the type of projects the Innovation Network is involved in is given in the appendices (Transitions in the greenhouse sector).

[21] It should be noted that this aspect– as opposed to the other Sectoral Councils – plays only a minor role in the work of the Innovation Network.

5. The relationship with other instruments in the portfolio

The relationship with the other instruments is more or less straightforward. The programming and priority-setting function of the SC is an important input for those persons engaged in allocating budgets for research and innovation. Network building and demand articulation, a common element of exploratory studies and a component of system innovation management, facilitates the diffusion of knowledge within the network (and *vice versa* the flow of information about the wants and needs of users to the research organisations). Exploratory studies and strategy development at system level help individual actors/parties/organisations to make up their minds and develop and implement their strategies.
In short, the work of the Innovation Network has the potential to greatly improve the efficacy and efficiency of a fair part of the other instruments. Unfortunately, it is still too early to say whether or not this potential is indeed being exploited. This question is all the more pressing because the too low impact of the 'former NRLO style' was the only, albeit mainly negative conclusion of the evaluation.

6. Evaluative questions

As was the case in point 5, here too must we restrict ourselves to the potential of the Innovation Network.
The contribution to the five functions as specified in section 3:

Function 1 + 2: the management of interfaces and building networks.
Network building is pivotal for the new role of the Innovation Network. In combination with joint vision and ambition development, the interfaces management function is also covered.
From the evaluation however it also appeared that the NRLO tended to be somewhat conservative, avoiding the real controversial issues. The challenge for the Innovation Network is not only to build new networks (creating *Neue Kombinationen*), but to break down existing networks as well (creative destruction).

Function 3: providing a platform for learning and experimenting.
This function is central in the Innovation Network's new mission. The network can build on experience with various methods used in foresight exercises, but they did not acquire much experience in bringing the visions and ambitions into action. Nevertheless, without a doubt the work carried out by the Innovation Network will turn out to be an excellent laboratory for studying these processes.

Function 4: providing strategic intelligence.
One of the two major functions of the Innovation Network. The 'former' NRLO had already built up a large amount of expertise and experience in this area. However, up to now the integration of this type of strategic intelligence in a wider network that enables the exploitation of synergy and scale effects, has hardly been realised.

Function 5: stimulating demand articulation, strategy and vision development.
Performing this function is the vehicle for building the networks the Innovation Network is supposed to build. Here too, however, the demand for best practices in terms of methods, approaches and instruments has not been met by far.

Effectiveness, impact:
This is difficult to say, it is the major challenge facing the Innovation Network. The history of the NRLO is not so positive in this respect. Meanwhile however three important actors in the field (government and knowledge infrastructure) have committed themselves to the approach chosen by the network.

Efficiency, price/quality ratio:
Too early to answer this as yet; more experience and more in-depth analysis is still necessary.

Barriers and incentives:
The following research topics could help to reinforce the management of systems innovation:

- the design of effective process architectures and process management;
- accepted criteria for sustainable development;
- a methodology for futures research and to stimulate future orientation/vision development;
- breaking through existing patterns and structures without sacrificing commitment: stakeholder analysis, strategic niche management, facilities for learning and experimenting;
- a portfolio of instruments to collect information for design purposes and to test developed scenarios and strategies;
- how to systematise learning on system innovation.

The government's role:
Keeping its distance as far as the facilitating role is concerned. Active and learning partner in those cases in which government is one of the relevant actors in the innovation process..
Medium-range financing (five years), thorough evaluation.
In their role as actors in innovation in the agricultural system, relevant government institutions should play an active and constructive role without taking the lead.

Suggestions for improvement:
Too early to answer this, more experience and in-depth analysis is still required.

To conclude:

NRLO	LEGITIMATION		TYPE OF KNOWLEDGE				SYSTEM LEVEL		TYPE OF SUPPORT		NATURE OF PROBLEM	
	Market failures[22]	System failures	β	γ	βγ	Tacit	Organisation	System	Organisation	System	Operational	Strategic
	+	+++	+	+	++	++	+	+++	++	++		++

NRLO	PRIMARY GOAL	CLIENT	CONTENT	PROCESS	SYSTEM
	Systems innovation Network building Exploratory studies	Networks with four interlinked but different types of actors	Strategic Intelligence Visions, strategies, experiences Codified and tacit knowledge	Raising awareness Management of systems innovations	System organiser; System builder; Mgt interfaces; Identifying, mobilising, involving users; Developing infrastructure strategic intelligence

22 See Van Dijk & Van Hulst (1988) for a discussion on the market failures that legitimate government intervention in innovation processes.

Case 2: The Programme for Sustainable Technological development (DTO)[23]

1. Introduction

In the early 1990s, after the emergence of the Brundlandt report, an increasing amount of attention was given to sustainable development. In the Netherlands for example this was evident in the National Environmental Policy Plan (1989). The orientation on sustainability was mainly limited to 'end of pipe' solutions and existing technologies, and it was also characterised by a short-term focus. Technology was associated in a negative sense with sustainability, and policy makers engaged in aspects of innovation and technology hardly gave any attention whatever to the contribution of technologies to a more sustainable society. This situation inspired a high official of the Ministry of Housing, Spatial Planning and the Environment to develop plans for a research programme in which possibilities were sought to have technologies play a positive role in sustainable development. The name of this programme was the Programme for Sustainable technological Development (in Dutch '*Programma Duurzame Technologische Ontwikkeling': DTO*)
The major goal of this programme was twofold. First, policy makers had to be convinced of the necessity of the potential of new technologies in the development of sustainable technology by illustrating how such development of such technologies could be initiated and managed. Secondly, the program tried to influence technology developers in order to allow them to give more attention to sustainable technology. Therefore, the clients of this programme were part of the so-called 'quadrangle': trade and industry, government, knowledge institutes and social groups. In summary, DTO tried to convince the actors in this 'quadrangle' that sustainable technological development was not only possible but that it was also a necessity if an environmentally friendly society was to be achieved, and the environmentally sustainable goals set by Brundlandt realised. The expected results of DTO reflected these goals:

- to provide a description of technological challenges in relation to sustainable concepts;
- the translation of these challenges into proposals for pilot projects that clearly illustrated the role of these technologies in promoting sustainable development;
- experiences with these demonstration processes should lead to recommendations for universities and companies on how to include the aspect of sustainability in their research.

2. Context

Between 1990 and 1992 the high official referred to above, together with one of his colleagues, developed a number of ideas and plans that ultimately resulted in a programme called Sustainable Technology Development (*DTO, Duurzame Technologische Ontwikkeling*). Starting point: within 50 years, all processes should be 20 times as eco-efficient as they are now in order to realise a truly world-wide, sustainable society.
The programme started in 1993 and was supposed to come to an end after five years. It was financed and backed by five ministries, namely the Ministry of Housing, Spatial Planning and Environment, the Ministry of Transport, Public works and Water Management, the Ministry of Economic Affairs, the Ministry of Agriculture and Fisheries and the Ministry of Education, Culture and Science.

The basic philosophy behind the DTO programme is that structural changes are essential if we are to achieve a truly sustainable economy and society. Not only changes related to the technological aspects, but also changes in economic, ecological, socio-cultural and institutional systems. Moreover, these changes are often very much intertwined. Such a complex process of change is called a transition. To be more precise a transition is defined as: *...a large-scale, lengthy and complex societal trajectory of change.*

Although technology is often the prime driver of such a transition in the case of the DTO, it will influence the other aspects as well (working as a 'lever') and in doing so provoke changes in other parts of the system as well. Taking such a system/transition approach as the point of departure for policy making in the area of sustainability is in sharp contrast with earlier policies that stimulated environmentally friendly (technological) developments by imposing quotas and restrictions. However, it is difficult to design and implement such policies: the levels of change and complexity are high and the time scale is very short (Van Kasteren, 2000:1). Furthermore, the scope of such a transition is wider. More actors are included (multi-actors, the representatives of the 'quadrangle') and often new relations between actors have to be established and maintained (*Neue Kombinationen*, sometimes – but not always – linked up with the creative destruction of old networks and systems)). Transitions also typically appear on various organisational levels. What we are speaking of here is a multi-level occurrence: ranging from individual actors to national and international governments. Finally, the DTO programme is also a multi-arena project. Sustainable solutions are sought in different areas of society. A total of five arenas, based on the basic

[23] Special thanks to Gertjan Fonk for his useful comments on earlier versions of this case study.

needs of human beings were identified in the DTO programme: nutrition, housing, water, transport and chemistry.

The DTO programme used a special methodology to develop and implement transition projects (or projects that encourage transition). This methodology will be described in more detail in the next section. In short it boils down to the following: actors from various backgrounds create visions on a sustainable future. These visions are then translated into demonstration projects by means of 'back casting' (as opposed to forecasting). This methodology is a participatory one: stakeholders intervene actively in the design and execution of these projects.

To conclude, the DTO programme is characterised by:
- policy orientation;
- numerous, different sorts of actors;
- the opportunity to experiment;
- interaction between the short and long term by means of the design of desirable, sustainable futures and 'back casting';
- an emphasis on the process of making society more sustainable with the participation of the actors. This interaction with stakeholders makes the project a demand-articulated and systemic one, and boosts the support of as many actors as possible;
- technology is used as a 'lever' for societal change. As mentioned above, in the context of sustainable development this is quite a new approach. As a rule, technology has always been used for making products and processes more efficient under the pressure of, for example, a quota. In the DTO approach, the co-evolution of society and technology is stressed, and thus technology is seen more as an instrument to help realise the necessary breakthroughs.

The DTO programme is a typical example of a systemic policy instrument because it conforms to all the elements attributed to such an instrument as shown in Table 1. The organisers attempt to support a large variety of designs, build new networks by strengthening linkages, contract 'prime movers', try to raise awareness, and focus on the long-term horizon.

3. Description of the instrument and its function(s)

DTO is an experimental research programme that has the intention of contributing to a more sustainable society at global level by means of:
- defining criteria for sustainability;
- the design of technologies and/or systems that help to fulfil needs in a sustainable way and are easy to communicate;
- disseminating the DTO philosophy.

DTO focuses on five areas of societal needs (nutrition, transport, water, housing, chemistry) and takes stock of (technological) problems in these areas. Based on this analysis, 15 projects were defined in order to illustrate how sustainable technologies can be developed and diffused in these areas, and what impact these technologies might have. These projects are called: illustration processes. DTO is considered a success if four of these illustration processes are successful (successful in this case being defined as: a broadly-based vision of the future, specific projects being started up on the basis of this vision with real (financial and moral) commitment of all relevant actors).

In order to realise this, DTO uses a specific methodology. The process follows a series of steps outlined below[24] (see also: Aarts, 1997 and Van Kasteren, 2000:1):
- *Strategic Problem Orientation*: analysis of the problem area, including the initial identification of the physical and normative aspects of unsustainable aspects of society.
- *Analysis of stakeholders*: drawing a 'social map' of the chosen topic and problem field, consisting of all the relevant, directly or indirectly involved actors. This stage also involves encouraging the joint support of sustainable solutions. It is important to involve various actors in this identification process.
- *Drafting the future*: asking the various actors how they see a sustainable future 50 years hence. In doing so, participants are asked to make a huge leap into the future and to think in terms of breakthroughs. During the programme many instruments and methodologies were used to assist the actors in this process.

[24] The same approach was used in the illustration processes.

It should be pointed out here that this 'design' of the future should not be perceived as a blueprint but rather as a term of reference.

- *'Back casting'*: the vision of the future serves as a starting point from which to reason back. In this way, all the steps and breakthroughs needed to realise the designed vision are identified. This process results in several projects in which a more in-depth investigation is made as to how the gap between the present and the future can be bridged.
- *Short term tackling*: the 'illustration projects' are carried out by representatives of the 'quadrangle' and the initiator of the project (a company for instance). These groups are also assisted by a DTO director. DTO experience shows the importance of including such a 'prime mover'.

The organisation of the DTO programme was based to a large extent on project organisation under the supervision of a Board of Directors (consisting of several representatives of the participating ministries). The organisation itself consisted of only a few members (two directors, one secretary and the project coordinators). There was also a feedback or brainstorming group in which 'representatives' of the target group (the 'quadrangle') participated.

4. The process of implementation

Because of the project's short time horizon, all stages of the cycle as described in section 3 were conducted only once. In order to stimulate creativity and gain the support of as many actors as possible (two very important conditions for interactive processes), the project organisation welcomed the contributions of these actors. A joint search process was carried out in each stage of the cycle. The DTO management did not see the role of project leader in a traditional (directive) role since one of the objectives of the programme was to find out how the various roles must be filled in order to obtain optimal results. It would have only been arrogant in this situation to play down the suggestions made by the other parties; it would also have frustrated the learning process. Building up the network reinforced the demand-driven approach and intensified the actors' commitment to solutions they had themselves proposed or even created.

In 1996, nearing the end of the programme, several parties said to share the opinion that the results of the DTO programme were not well anchored. As a result the programme was prolonged under a different name: DTO-KOV (*KOV, KennisOverdracht en Verankering*: Knowledge Transfer and Anchoring). The target group was expanded with the inclusion of educational institutions.
The DTO-KOV stage drew heavily on the project-based organisation itself and consisted of three main components:

- *Learning-by-doing*: the bureau played an advisory role and financed other projects.
- *Education*: based mainly on the requests made by schools and universities themselves., The projects were therefore executed by them too. The only role the bureau played was that of the supplier of knowledge and experience, co-financer and coordinator together with other collaborators.
- *Communication*: several activities such as seminars, several meetings, a newsletter, a website and other communicative activities such as lectures, workshops and classes. The bureau organised meetings on a regular basis in which the participants learned how to come to grips with the DTO approach.

5. The relationship with other instruments in the portfolio

Although there was no interaction with other instruments intended, it was obvious that links with other instruments would be established. The results of the illustration processes may help to allocate research funds to promising projects. The DTO programme was quite successful in generating the resources needed. Nevertheless, input from other financial instruments is necessary to ensure continuity in the starting up of new projects. Furthermore, DTO can be seen as a context in which instruments focusing on the diffusion of research results are facilitated. Moreover, DTO may help the various actors to include the aspect of sustainability in their strategic plans and could be a stimulus for the development of new technology-based 'green' products and services with an added value in terms of sustainability. This makes it possible for DTO to reinforce the impact of managerial instruments. To conclude, other systemic instruments could have been used. For example, several Technology Assessment techniques could be useful in the 'Strategic problem orientation' and 'Analysis of stakeholder' stages.

6. Evaluative questions

Contribution to the five functions described in section 3:

Function 1: the management of interfaces:
The demand for sustainable solutions was expressed, especially in the first two stages of the DTO cycle. Forming groups of actors around several subjects was the start to building up a network. While there was less attention devoted to the transfer of knowledge there was still a certain amount of interaction between the researchers involved in the illustration processes and DTO issued a newsletter.

Function 2: building and organising innovation systems:
As explained above, new combinations were sought between the actors of the 'quadrangle'. Prime movers were mobilised to promote sustainable solutions and stimulate developments. By analysing the stakeholders (second stage) it was made sure that all relevant actors are able to participate in the network. Less attention was given to the destruction of old institutions (which is not feasible because of the small scale of the programme) and the prevention of lock-in (it must be pointed out here that drafting out the future implicitly implies assumptions and this results in the origination of lock-in).

Function 3: providing a platform for learning and experimenting:
Combined with the Knowledge and Anchoring programme the DTO programme scores high on this aspect. This is one of the projects' main goals. In the DTO programme the participating actors learn how to apply and experiment with the DTO strategy. The latter, because the strategy is being used for the first time, and the DTO bureau stimulated it because they wished to improve their strategy (learning-by-doing on a different, organisational level).

Function 4: providing an infrastructure for strategic intelligence:
By making clear the needs of the society in the first stages, the programme exposes the strategic information that was needed for the actors to draft out the future and think about the implications for projects with a shorter time horizon.

Function 5: stimulating demand articulation, strategy and vision development:
Potential applications of the identified demand-driven needs for a sustainable future were made more clear by organising projects.

The following flaws came to the fore from an evaluation of the *DTO programme* (Andringa et al., 2001; Van Kasteren, 2000:1 and Aarts, 1997):

- The programme failed to develop that particular picture of the future that forms the basis for the identification of gaps and opportunities that must have the support of as many actors as possible.
- There was insufficient insight into the development areas in which projects can be initiated and stimulated.
- There was no mechanism besides the DTO programme able to initiate similar initiatives.
- Some facilities for producing the projects, such as financing and changing regulations, were not well supplied. DTO intended to make some recommendations on these subjects but they were not submitted.
- The DTO programme definitions (for example those on sustainable aspects) were not always described in specific and unambiguous terms.
- Radical technological innovations hardly played a role in the illustration projects. Most of the projects focused more on cultural and structural barriers than on technological ones.
- Communication with the general public was inadequate.

Nevertheless, the program did show some positive results, such as the setting up of 15 innovative illustration projects, R&D schedules, a draft report on how to manage innovation processes concerning major changes in the future and the networks required to do so. Moreover, the programme was followed up by several unintentional spin-off projects.

The last flaw (the lack of communication) was tackled with the *DTO-KOV programme*. The weak spots of this part of the programme were:

- The already visible tension between the project coaches and the participants failed to be eliminated during the DTO phase. The coaches wanted to focus on the DTO strategy, while the participants preferred to devote more attention to the actual execution of the project and had not expected the coaches to play such a large role in terms of content.
- There was too little time and a lack of resources to make full use of all the knowledge available from the bureau.

Positive results included the firm integration of DTO strategy in educational programmes and a deeper understanding of the strategy because of the Learning-by-doing projects, not only for the participants, but also for the DTO experts.

Based on the evaluations of the programmes that have since been carried out, it is difficult to say whether the two goals (raising more awareness of the DTO approach and giving more attention to the contribution of technological solutions towards sustainable development) have been fully realised.

Effectiveness, impact:
One important impact that has been achieved is the establishment of NIDO, the Netherlands Institute for Sustainable Development. Furthermore, the experiences gathered at DTO were used in the transformation of the NRLO into the Innovation network as described earlier. More detailed information on the impact of DTO is as yet unavailable. The widespread impression is that while DTO realised many of its goals (Weaver et al., 2000), a more in-depth analysis is necessary in order to fully understand the programme's impact on the 'innovation system'.

Efficiency, price/quality ratio:
Because the other actors in the 'quadrangle' shared the burden from the perspective of government, this programme was quite cost effective.

Barriers and incentives:
The following research topics could help to reinforce the management of systems innovation and transitions:

- how to systematise/standardise the stages in the DTO programme in such a way that a minimum of assistance is required by the programme bureau;
- accepted criteria for sustainable development;
- developing a methodology that simplifies the design of vision of the future;
- identification of the areas in which sustainable development is an urgent problem and for which the DTO methodology is a suitable method of approach.

The role of government:
An important, but nevertheless only one of the many actors. The ministries did not exercise any influence despite the fact that they financed the programme.

Suggestions for improvement:
There is still a great deal to learn from this valuable exercise. Only after a more in-depth analysis will it be possible to make recommendations as to how the effectiveness and efficiency of such a programme can be increased further. There is one remark, however, that can be made: there is a major need for mechanisms that enable the start-up of ambitious programmes like the DTO programme. It is the intention that NIDO, mentioned in the foregoing – sometimes regarded as DTO's successor – should play such a role.

DTO	LEGITIMATION		TYPE OF KNOWLEDGE				SYSTEM LEVEL		TYPE OF SUPPORT		NATURE OF PROBLEM	
	Market failures[25]	**System failures**	β*	γ**	β γ***	**Tacit?**	**Organi-sation**	**System**	**Organi-sation**	**Sys-tem**	**Opera tional**	**Strate-gic**
	+	+++	+	+	+++	+++	+	+++	++	+++	+	+++

* **Science**
** **Social Science**
*** **Science and Social science**

25 See Van Dijk & Van Hulst (1988) for a discussion on the market failures that legitimate government intervention in innovation processes.

DTO	**Primary goal**	**Client**	**Content**	**Process**	**System**
	Placing sustainable technological development on the agenda; Learning; Network building;	The 'quadrangle': government, firms, knowledge institutes and social groups;	Strategic Intelligence; Visions, strategies, experiences; Codified and tacit knowledge	Stimulate learning; Stimulate experiments; Mgt complex projects; Strategy / vision development; Demand articulation; Mgt of systems innovations; Raising awareness;	System organiser; System builder; Mgt interfaces; Identifying, mobilising, involving users; Developing infrastructure strategic intelligence

More information can be found on the DTO-KOV website: www.dto-kov.nl

Case 3: The cluster approach[26][27]

1. Introduction

Clusters (economic and the increasing number of newly created innovation clusters) can be characterised as production networks of strongly interdependent firms (including specialised suppliers) linked to each other in a value-adding production chain. In some cases, clusters also encompass strategic alliances with universities, research institutes, knowledge-intensive business services, bridging institutions (brokers, consultants) and customers. Clusters are usually cross-sectoral (vertical and/or lateral) networks and contain dissimilar and complementary firms specialised around a specific link or knowledge base in the value chain[28] (Roelandt et al., 1999b; den Hertog et al., 2001).

Over the last two decades, the cluster approach has attracted the attention of researchers and policy makers alike in various countries. Since the mid-1980s different cluster concepts and approaches have been developed (Roelandt et al., 1999, p. 315), although the notion of a cluster actually goes back as far as Marshall (see e.g. Peneder, 1999)[29]. The cluster approach is part of the growing family of innovation systems approaches (Edquist, 1997; Malerba, 2000). Clusters can in fact be interpreted as reduced-form national innovation systems: the system dynamics, interdependencies and emphasis placed upon 'systemic imperfections' are similar to those for national innovation systems. Clusters, by definition, transcend the borders of individual sectors and industries[30]. The cluster perspective offers useful insights into how these dynamics, interdependencies and the related institutions are shaped, how they evolve over time and how they affect innovation, and defines the scope that exists for policy action (den Hertog et al., 2001).

Here we will focus mainly on cluster innovation policy in general as an example of a development towards a new generation of more systemic innovation policy instruments and the demands it makes on policy-makers[31].

2. Context

The cluster approach focuses on facilitating networks and creating the institutional setting that provides incentives for market-induced cluster formation and for the revitalisation of existing clusters. For policy makers, it can be seen as a tool for knowledge and innovation management that can pinpoint those actions that are most needed to overcome barriers to innovation and to customise these actions to a specific cluster (den Hertog et al., 2001). In fact clusters can be perceived as offering a robust organising framework for addressing or removing *systemic imperfections* in innovation systems (see box below).

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26 This case was contributed by Pim den Hertog, Dialogic Utrecht, denhertog@dialogic.nl.

27 This section leans heavily on OECD (2001) and OECD (1999) to which the author of this section contributed both as editor and author of various chapters.

28 This typically is a value chain or 'Porterian' definition of a cluster, and quite a few researchers as well as practitioners adopt a more 'classical' defintion of a cluster in which similarity, shared resources (be it production factors, a technology, even a local culture, etc.), and geographical concentration are the key. In practice, most value chain clusters seem to concentrate geographically. However, in our view this is not a necessary condition. Not only do we witness the rise of 'virtual clusters', it also depends on the level of aggregation. For instance there are only a few clusters that dispose of complete integrated ICT clusters such as Silicon Valley. Most local or regional ICT clusters are part of wider and increasingly international ICT value chains!

29 For a review, see Jacobs and De Man (1996). As Boekholt et al., (1999, p. 382) rightly observed, the cluster studies have their origins in the literature on industrial districts, based on empirical research in regions generally consisting of mature industries (Piore and Sabel, 1984; Morgan and Cooke, 1991) such as Emilia-Romagna and Baden-Württemberg, Silicon Valley, Boston Route 128, Sophia-Antipolis. New rounds of more value chain based type of cluster studies and cluster policies were triggered by the work of Porter (1990).

30 For a schematic overview of the major differences between cluster and sectoral approaches, see Roelandt et al., 1999a, p. 13.

31 For an overview of the results of identifying and analysing innovation clusters and examples of cluster approaches as used in various countries see OECD (1999); OECD (2001); Bergman and Feser (1999).

Systemic imperfections as the leading rationale

The competitiveness of a country's innovation system depends upon the synergies that arise from the interaction between actors involved in the innovation process. A rationale for economic policy, directly deduced from the innovation systems approach, refers to removing systemic imperfections which hinder the realisation of these synergies: informational and organisational failures and externalities. These systemic imperfections can, for instance, result from a lack of strategic information (on market developments as well as on public needs), bottlenecks in dialogue and cooperation between the various actors, or environmental and knowledge externalities. Policy responses to systemic imperfections encompass, for example:

- Establishing a stable and predictable economic and political climate.
- Creating favourable framework conditions for the efficient and dynamic functioning of free markets and removing market imperfections.
- Stimulating interactions and knowledge exchange among the various actors in systems of innovation.
- Removing informational failures by providing strategic information.
- Removing institutional mismatches and organisational failures within systems of innovation, such as mismatches between the (public) knowledge infrastructure and private needs in the market or a missing customer in the value chain.
- Removing government failures and government regulations that hinder the process of clustering and innovation.

This list clearly illustrates that the rationale of systemic imperfection is broader than the old market imperfection argument since the point of departure here is the functioning of the innovation systems as a whole and not so much the perspective from an individual firm (largely based on Roelandt et al., 1999a, p. 17/18).

The notion of systemic imperfections, as well as the growing importance of clustering, has resulted in the redefinition of the role of governments in industrial and innovation policy making in a number of countries. In most countries, this changed perspective has resulted in the creation of support structures, such as broker and network agencies and schemes, and the provision of platforms for constructive dialogue and knowledge exchange. The main task of the public policy maker has become one of facilitating the clustering process and creating an institutional setting that provides incentives for market-induced cluster formation (Morgan, 1997).

In practice, the cluster approach has proven to be quite a useful framework for developing and applying new forms of governance, moving away from direct intervention towards forms of indirect inducement. The use of existing instruments in new combinations, uncertainty, experimentation and policy learning are very much parts of cluster policy practices. As cluster approaches are policy mixes customised to the needs of very different clusters (even if they have the same name) it must be emphasized that there is neither a standard cluster approach, nor a fixed policy recipe for implementing the cluster approach in practice. Depending on the analysis of what is hampering the further development of an existing cluster – or the emergence of a new cluster – various cluster-oriented policy-actions and tools could be brought into place as illustrated in exhibit 9.

Exhibit 9: **Cluster policy rationales, initiatives and tools**
Boekholt et al, 1999

Policy rationales	Cluster-oriented policy action	Tools
Lack of cluster identity and awareness	Identification and public marketing of clusters	Mapping exercises External promotion of regional clusters External/internal promotion of cluster member's competencies
Government regulations hamper innovation or competitiveness	Organise cluster specific forums to identify regulative bottlenecks and take actions to improve them	Cluster platforms and focus groups Tax reform Regulation reform (environment, labour markets, financial markets)
Private enterprises fail to take up opportunities for collaboration with other firms	Encourage and facilitate inter-enterprise networking Purchase innovative products through collaborative tendering procedures	Networking programmes Brokerage training Public procurement for consortia
Private enterprises, particularly SMEs, cannot access strategic knowledge	Support cluster-based retrieval and dissemination of information Organise dialogue on strategic cluster issues	Set up cluster-specific information and technology centres Platforms to explore market opportunities Foresight exercises
Private enterprises do not utilise the expertise of knowledge suppliers	Collaborative R&D action and cluster-specific R&D facilities	Set up cluster-specific technology and research centres/initiatives Subsidise collaborative R&D and technology transfer
Lack of crucial elements in a cluster	Attract or promote growth of enterprises in cluster Attract major R&D facilities	Targeted inward investment Support start-up of enterprises in a particular cluster

3. Description of the instrument and its function(s)

As already indicated in the foregoing, the cluster perspective is more an approach than a fixed tool or instrument. Choosing to adopt a cluster approach does not imply working with one or two ideal policy tools to increase the innovativeness and adaptation capabilities of a particular cluster[32]. What might benefit one cluster in one country could possibly be counterproductive elsewhere. In one cluster, policy actions can be limited to making sure that competition is sound; in other clusters, it might consist of various roles (demanding customer, technology foresight, creating the appropriate knowledge infrastructure, looking after competition practices, IPR problems, etc.). The main task of policy makers supporting innovation in clusters is to facilitate the networking process and to create an institutional setting which provides incentives for market-induced cluster formation and forms of cooperation in emerging *and* mature clusters. They have at their disposal a set of possible roles, instruments and analytical tools from which they can choose. Examples of innovation policy measures include: raising awareness of the benefits of knowledge transfer and networking; providing support and appropriate incentive schemes for collaboration; initiating network brokers and intermediaries to bring actors together; facilitating the informal and formal exchange of knowledge; setting up competitive programmes and projects for collaborative R&D; and ensuring that (public) institutions (especially schools, universities, research institutes) cultivate industrial ties. Many of these policy measures are clearly related to our 'systemic functions'.

Having said this it can be useful to reflect upon the level of aggregation at which cluster policies are put in place, and on the sort of general policy models that are behind cluster policies. In reviewing cluster and cluster-like

32 In other words, there is no standard policy recipe or fixed policy; it is more appropriate to perceive this as a 'menu approach'- as introduced by Jacobs et al., (1996) – from which the right ingredients should be chosen in each case.

policies in a large number of countries, Boekholt et al., (1999) provide us with a more systematic overview[33] (see exhibit 10). They first differentiate between cluster policies at three levels i.e. the mega-level, meso-level and micro-level. Later they draw a distinction between four general 'policy models' which have taken the lead in the sort of cluster and cluster-like policies put in place. These four policy models are to improve:

- the 'national advantage' of certain clusters (or broadly defined sectors) or value chains;
- SME competitiveness;
- the attractiveness and the economic performance and development of a region;
- to intensify industry-research collaboration in specific technologies or types of firms.

Exhibit 10: **Policy models and their main instruments and public roles**
Boekholt et al., 1999

	Mega level	Meso level	Micro level
1. National advantage	Mapping Competitive markets Regulations and standardisation	Foresight studies *Specialised RTD facilities*	Collaborative RTD programmes
2. Inter-enterprise (SME) networking		Supply chain development	Brokerage Networking programmes Awareness raising
3. Regional development	Regional Competence Centre development	Focused Inward investment Supply-chain associations Specialised technology transfer Marketing clusters	Brokerage Networking programmes Awareness raising
4. Industry-RTD clustering	Incentives RTD-industry collaboration (IPR, financial, etc.)	Collaborative RTD centres programmes in specific areas Prioritisation of R&D expertise	Technology circles NTBF support Procurement policy

4. Implementation process

As to the implementation of cluster policies in general, a few comments can be made. In the first place the choice of what role, instrument and analytical tool to use, and when, not only depends on the needs of the actors in a particular cluster, but also on the stage in the cluster's life cycle. Over the life cycle of a cluster, various constellations of actors ask for various sorts of facilitation by policy makers. The sort of tools a policy-maker might wish to use to support a nascent nanotech cluster will be quite different from the tools a policy maker would propose for triggering innovation in more mature clusters such as construction or agro-food.
Secondly, the type of practical instruments used in cluster policy depends on the degree to which policy makers are prepared to customise policies to particular clusters. The Finns, for example, have not chosen strong cluster-specific policy. Instead, in accordance with a government role perceived primarily as a facilitator, it was decided that policy should not favour any specific cluster over others (see Romanainen, 2001). There are quite a few examples around – for example Denmark, Scotland, the Netherlands and many other regions – where initiatives aimed at and customised to the needs of one or a few clusters have been brought into place. In general, a major trade off is the one between favouring existing clusters and identifying and facilitating emerging innovation clusters[34].

Thirdly, in implementing the cluster approach one should be aware of the ever-present policy cycle. This cycle requires differentiation between the political decision to adopt a cluster approach and the bureaucratic logic of implementing this approach. Or as Benneworth et al., (2001, p. 391-392) phrased it: "once the decision has been

33 For a more detailed description see Boekholt et al., 1999, p. 387 onwards.

34 In many respects, the cluster approach requires a balancing act by policy makers (balancing new and established clusters, balancing technology-based and non-technology-based clusters, balancing supporting cooperation and not destroying competition, etc.).

taken to support a particular cluster, then the cluster policy enters a much more technocratic phase from strategy formulation to program delivery. Willing participants in the cluster are identified, aims and targets for the cluster determined, and then actions are planned and delivered. Finally, because of its political nature, there is an evaluation and reporting-back stage, where lessons are learned, and the possibilities of subsequent policy phases evaluated. The policy finally re-emerges into the political sphere, where its appropriateness and efficiency as a policy measure can be democratically debated, and decisions taken over the future of cluster policies."

In a similar vein the decision to adopt a cluster approach has serious implications for the individual cluster policy maker. For cluster policies to be successful, a 'new breed' of policy makers is needed in the first place. They need to combine the analytical skills required to obtain an in-depth understanding of the innovation dynamics and innovation style of a particular cluster and the flexibility to decide on their most appropriate role (including the decision that there might not be a role to play!) to foster innovation. This mostly requires a trajectory of experimentation and constant policy learning as policy making related to clusters involves a great deal of 'trial and error'[35] (see den Hertog et al., 2001).

Further, cluster policy makers need to be able to mix and switch between various roles. Policy for innovation, as much as innovation itself, is a learning process. By this it is clear that cluster-based policies aimed at furthering innovation require intelligent, flexible and creative policy makers, capable of engaging in a trajectory of policy learning and experimentation, constantly switching between analysis and pragmatic action.

5. The relationship with other instruments in the portfolio

It will be obvious that cluster policies will have a tremendous impact on other instruments in the innovation policy instrument portfolio. Cluster policies affect interactions between firms and knowledge institutions, improve the (technology) absorptive capacity of firms, have an impact on the flows of knowledge, money and people between actors and – because of their strategic dimension – provide a context and guidelines for allocating R&D investments.

Even more important, however, are the strong relations with policies and policy instruments outside the innovation domain. The innovative capacities of clusters are shaped by all kinds of policies (including non-innovation policies). This is especially apparent when the history of certain clusters is analysed in more detail. What is important is that many of the policies that shape clusters lie outside formal 'cluster policy' or even industrial, technology and innovation policies. Each cluster is affected by a complex interplay of policies influencing the trading environment, sources of innovation, the nature of places where cluster resources come together and the regulation of the cluster. A focus purely on innovation or industrial policy, without such a broad and historically contextualised perspective, will yield a narrow and myopic view. The history of the Danish construction cluster shows that policy intervention played a substantial role at all levels in shaping the cluster and the scope for innovation (see Dahl et al., 2001). The direction of innovation in the construction cluster was seriously affected by macroeconomic policies (the construction cluster was used to stabilise the overall economy), but also by detailed specifications and building standards in private homes, housing policies, energy-saving policies and fiscal policies. Some of the resulting innovative strongholds in the Danish construction cluster, such as energy-efficient construction, can be said to have been actively shaped by government. However, many policy initiatives and regulations that affected innovation in clusters were not intended to support innovation. In conclusion, clusters and innovation in clusters are as much influenced by other types of policy making as by explicit cluster policies (den Hertog et al., 2001).

The foregoing also implies that policies not specifically aimed at innovation can be used as levers to support innovation in clusters. Hence, there is a need to look at a wider array of policies and their interactions in policy systems. In practice, policies aimed at facilitating innovation in clusters require appropriate and customised doses of intervention by policy makers that more often than not consist of fairly limited actions. This also implies that cluster policy makers might need to intervene in policy areas and policy domains that may not be immediately associated with innovation policy often requiring interdepartmental coordination. Cluster policy then is a rather general approach to policy making and an action tool to optimise framework conditions for innovation in clusters.

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35 Increasingly, this learning and experimentation will have to take place in an international context. Not only is it good to reflect on how policies for facilitating innovation in clusters are dealt with in other countries, but strongly internationalised clusters require appropriate policy responses as well. As noted by Romanainen (2001) one of the most pressing challenges for the cluster approach is to deal with strongly internationalised clusters. Another way of working on the continuous improvement of cluster-based innovation policies is to evaluate experiences as systematically as possible, not only to increase the accountability of cluster-based innovation policies, but also as a way of codifying 'best practices'.

6. Evaluative questions

From the discussion as presented in the preceding (sub)sections it is apparent that it is almost impossible to discuss *the* cluster approach. Nevertheless it *was* possible to see why the cluster approach can be perceived as a systemic policy. In terms of the five functions described in section 3 we might conclude that most cluster policies are about the 'management of interfaces' between various actors involved in the innovation proces (1), that clusters are about 'building and organising (reduced-form) innovation systems' (2) and are in fact variation and selection environments or 'platforms in which learning and experimenting' are the key (3). The other two functions – 'providing a structure for strategic intelligence' and 'stimulating demand articulation, strategy and vision development' – are not absent, but seem to be less outspoken elements of the cluster approach. The cluster approach is further characterised in the two schemes presented at the end of this section.

Further, as cluster policies have not yet been evaluated systematically[36], it is difficult to systematically assess their effectiveness and efficiency, the more so as cluster policies are put in place at local/regional, national and sometimes transnational levels. It is evident that policy approaches, type of players involved and budgets available are quite different. There certainly is a difference between cluster policies that are old style industrial (especially at the regional levels) policies in disguise, aimed at keeping mature industries alive or artificially starting (instead of facilitating) new clusters from scratch and new style cluster policies. The latter seem to be more about sustaining and facilitating clusters by very focused and pointed policy actions. These actions can differ considerably between clusters and over the cluster life cycle. Policy is actively looking for the most appropriate role, and sometimes the conclusion might be that there is no such role. These new style cluster policies are not necessarily costly in terms of available budgets, they are costly in terms of the expertise and high demands put upon the civil servants in charge. They will have to be able to switch between various roles, be able to operate in between the various departments that might affect the opportunities for clusters to further develop and innovate and withstand the pressure to fall back into simply supporting industries or adopting standard approaches without too much consideration of the specificities of a certain cluster.

By way of conclusion we point at two major risks when adopting the cluster approach, namely 'high-tech myopia' and the adoption of standard policy models without further consideration.

A first risk for further development of the cluster approach is 'high-tech myopia' i.e. the risk that cluster policy makers and cluster researchers tend to mainly focus on 'high-tech' clusters and the obvious cluster success stories that are around. This is a major risk as it is usually forgotten that the rise of such clusters in the first place is the result of a combination of an often unique mix of mostly strongly localised factor conditions and development trajectories over decades that cannot be replicated overnight. The mechanisms and experience built up in clusters – no matter whether these are labelled as high-tech, medium-tech or low-tech – are valuable capacities. As long as clusters have built-in mechanisms to renew and re-invent themselves over time, this is a very precious asset. Therefore, characterising clusters as low or medium-tech might be misleading. Hauknes (2001) showed how knowledge-intensive a cluster like agro-food has become; the more so if one does not overlook the non-technological knowledge involved in innovation (den Hertog et al., 2001).

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36 Dutch cluster policies are currently being evaluated, the results of which are expected to be available in spring 2002.

PITFALLS OF CLUSTER-BASED INDUSTRIAL POLICY MAKING (Roelandt et al., 1999b)

- The creation of clusters should not be government-driven but rather should result from market-induced and market-led initiatives.
- Government policy should not be strongly oriented to directly subsidising industries and firms or to limiting rivalry in the marketplace.
- Government policy should shift away from direct intervention towards indirect inducement. Public interference in the marketplace can only be justified in the presence of a clear market or systemic failure. Even if clear market and systemic imperfections exist, it cannot necessarily be concluded that government intervention will improve the situation.
- Government should not try to take the direct lead or ownership in cluster initiatives, but should work as a catalyst and broker, bringing actors together and supplying support structures and incentives to facilitate the clustering and innovation process.
- Cluster policy should not ignore small and emerging clusters; nor should it focus only on 'classic', existing clusters.
- Clusters should not be created from 'scratch' in declining markets and industries. The cluster notion has sometimes been appropriated by (industrial) policy makers and used as an excuse to continue more or less traditional ways of defensive industrial policy making.

A second risk that follows from the above argument is that working with standard policy models and using a tool-push approach can be dangerous. Quite often, policy instruments and working tools are developed for particular vanguard clusters (for example, ICT or biotechnology) and subsequently applied to other innovation clusters without too much consideration. This is a particularly dangerous development as cluster policies are precisely about customising sets of policy tools to the needs of a particular cluster and not about applying any form of standardised cluster approaches. Similarly, at the level of individual cluster tools, there is the threat of a 'tool-push' approach, which may lead to failures[37]. Both policy models and cluster policy tools need to be applied with great care and a 'one size suits all' approach is counterproductive (den Hertog et al., 2001).

If not taken seriously, these two risk factors might hamper the further development of the cluster approach.

[37] Gilsing (2001), discussing the Dutch case, for example, suggests that the application of particular analytical tools (e.g. technology radar) was used too much in a standardised way in different clusters, leading to some disappointments.

Exhibit 11: **Summary cluster approach as a systemic policy instrument: main messages**

- Message 1: Clusters as reduced-form NIS are part of the growing family of innovation systems approaches.
- Message 2: Clusters can be perceived as offering a robust organising framework for addressing or removing systemic imperfections in innovation systems.
- Message 3: There is neither a standard cluster approach, nor a fixed policy recipe for implementing the cluster approach in practice as different innovation dynamics in clusters call for different (cluster-specific) actions, and there are multiple ways in which governments can have impact upon cluster behaviour.
- Message 4: Cluster policies and the actual policy tools used are very much shaped by the level of aggregation at which cluster policies are put in place and the sort of general policy models that are behind cluster policies.
- Message 5: Cluster policies are specific mixes of – to an important degree – exisiting instruments attuned to the specific needs of a cluster.
- Message 6: Cluster approach implies varying customised mixes of innovation and non-innovation policies. Both type of policies can be used as levers to support innovation in clusters.
- Message 7: Clusters as policy tools require experimentation and learning.
- Message 8: A first risk for further development of the cluster approach is high-tech myopia.
- Message 9: A second risk is adopting standard policy models and standard tools.

To conclude:

Cluster approach	*LEGITIMATION*		TYPE OF KNOWLEDGE*				SYSTEM LEVEL		PROCESS LEVEL		NATURE OF PROBLEM	
	Market failures	**System failures**	**β**	**γ**	**Bγ**	**Tacit ?**	**Organi-sation**	**System**	**Organi-sation**	**Sys-tem**	**Opera tional**	**Strate -gic**
	+	++	+	+	++	**formal tacit**	**Public Private Public & private**	**Institution /system Public Private Public & private**	+	++	+	+++

* β = science
γ = social sciences
Bγ = science / social science

Cluster Approach	**Primary goal**	**Client**	**Content**	**Process**	**System**
	Addressing systemic imperfections Right framework conditions Networking Regional development Industry-RTD clustering/interfacing	**Large firms Networks Industry associations Partnerships RTOs and Higher Education Institutions Public institutions**	**Strategic Formal Tacit**	**Collection of few to many projects Joint intelligence and agenda setting Experimentation and learning Management of interfaces**	**System organiser Providing framework conditions Designing interfaces**

Case 4: Futur

1. Introduction[38]

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. 'Leading 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 a broader audience in various kind of workshops and the combination of different communication and analytical methodologies are characteristics of the process. *Futur* has to generate priority suggestions until the end of 2002; afterwards the process may be re-iterated.

Futur is intended to introduce 'fresh ideas' into the research-funding portfolio of the BMBF, by way of bypassing 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.

In parallel with the *Futur* process, the BMBF established in 2001 an 'Innovation Council' (*Innovationsbeirat*), consisting of outstanding personalities from research, industry and societal groups, intended – amongst other consultative tasks – to comment and consult on the conduct and results of *Futur*.

From the very beginning there has been an in-built tension between open-endedness of the process and the clear mission to come up with *Leitvisionen* within a fixed, quite short period of time.

The major lessons learned up to the winter of 2001/02 are summarised in this paper. A more detailed evaluation will be conducted in the course of 2002 by an independent international foresight expert panel, supported by the Fraunhofer Institute for Systems and Innovation research (ISI).

2. Context: Foresight in German research policy

In Germany, foresight on the national scale was launched in the early 1990s. Starting with a survey of the 'Technologies at the Beginning of the 21st Century' (Grupp 1994) followed by a broad 'Delphi study' of future developments in science and technology, conducted in cooperation with the Japanese Institute of Science and Technology Policy (NISTEP) (Cuhls and Kuwahara 1994), the scope and the objectives of foresight in Germany have broadened considerably meanwhile. With the 'Mini-Delphi' studies of 1995 (Cuhls et al., 1995) the methodology was improved, and in 1998 a large German Delphi study followed (Cuhls et al. 2001), again in cooperation with the Japanese partner (NISTEP 1997).

All these studies were based on expert surveys or panels only (for an overview see Blind et al., 1999). They had a limited scope and a strict methodology. Foresight in Germany was mainly '(science and) technology foresight' according to Martin's definition (Martin 1995). But gradually, the definition and the observed fields were broadened. Later studies were called simply 'foresight' (i.e. were broader in focus than science and technology), similar to the British foresight, and aspects like networking and the creation of data bases were emphasised more and more (Cuhls 2000). The second national foresight study in Germany also addressed societal 'megatrends' at the global level (Cuhls et al., 2001).

A major criticism of the German foresight practice was that only experts have been involved, although the implemented definition of 'expert' was quite broad, and the experts were also invited to answer questions they were not specialised in. A bias in these kinds of studies was assumed: it was expected that experts would over-emphasise the importance of their own field of research. This, nevertheless, could not be proved in general (Blind et al., 2001; Berdecki 1984) but was certainly found in specific sectors like Energy.

Another point of criticism was that the results were not used strategically by the Federal Ministry of Education and Research (BMBF), who financed the foresight projects; they had no immediate impact on research funding prioritisation. On the other hand the studies found many other users, one of them being the Fraunhofer Society (the major German institution for applied research) which used them as a matching frame in the context of a system level evaluation of its strategic mission (conducted by an independent international committee)

38 This case study is largely adapted from: Cuhls, Kerstin (2002): *Futur* – Foresight for Priority-setting in Germany. In: IJTM, Special Issue (edited by Bowonder), forthcoming.

(Kuhlmann 2001). Most of the applicants utilised the data in a self-organised way (Cuhls and Möhrle 2002). And for the *Futur* process, Delphi data have been also been of value as input into the focus groups.

In order to counter such criticism and to open the German foresight practice for more and other participants, the (social democrat) research minister decided to launch the new process called *Futur*. Originally, *Futur* was designed chiefly on making use of the Internet. In June 1999 at a conference in Hamburg *Futur* started with two thematic fields, 'Mobility and Communication' and 'Health and Quality of Life'. As people in Germany were quite enthusiastic about foresight, not at least in context with the 'Millenium 2000', the ministry expected that it would suffice to provide an internet platform and some thematic inputs to provoke people's active participation. This approach failed because too few people were even aware of the process – and those who were failed to invest time in it, or were unaware of exactly what to discuss. Both methodology and direction of discussion were unclear. The Ministry decided to suspend *Futur*.

In spring 2001, *Futur* was re-launched. This time, methodology and the anticipated outcomes were pre-defined by BMBF. It was decided that working groups should add to the discussion, and the Internet should be used for information, transparency of the whole process and a workspace, but should not be the focal communication medium. A new consortium of conducting institutes was selected. This 'new' *Futur* will end in 2003 (though it may be re-iterated); up to late 2002 the process is supposed to generate priority suggestions (*Leitvisionen*). In the autumn of 2002 it might be subjected to political pressure as a consequence of national general elections.

3. Description of the instrument and its functions

Futur is directly linked to BMBF priority setting. Leading visions (*Leitvisionen*, desirable visions for the future) should be worked out in such a way that they can be directly translated into projects or programmes. The participation of persons from outside BMBF (experts and non-experts) is also a very important component in order to bring in new ideas and link them with BMBF programmes. This is an answer to much of the criticism mentioned above. 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 different perspectives of heterogeneous stakeholders had to be taken into account, thus meeting what Linstone (1996) called multi-perspectives. The *distributed intelligence* (Kuhlmann et al., 1999) of the whole innovation system should be mobilised for this purpose. The process is an iterative one and can be changed if experiences make it necessary to do so (reflexivity); different methods being combined to achieve this. BMBF is financing the process and plans to implement the results in its funding portfolio afterwards. A network of stakeholders ensures that both the BMBF and external persons are involved. The managing consortium is selected on the basis of neutrality and must assume the role of facilitator. In brief, *Futur* can be characterised by a number of key features:

- multiple perspectives and interdisciplinarity;
- orientation towards society's needs;
- participation of 'non-experts';
- a test of different communication and analytical methods;
- designed as a reflexive learning process;
- sketching 'pictures of the future' and 'leading visions' (*Leitvisionen*) as a guide to innovation-oriented research policy decisions, i.e. a link to implementation is included.

4. Implementation process

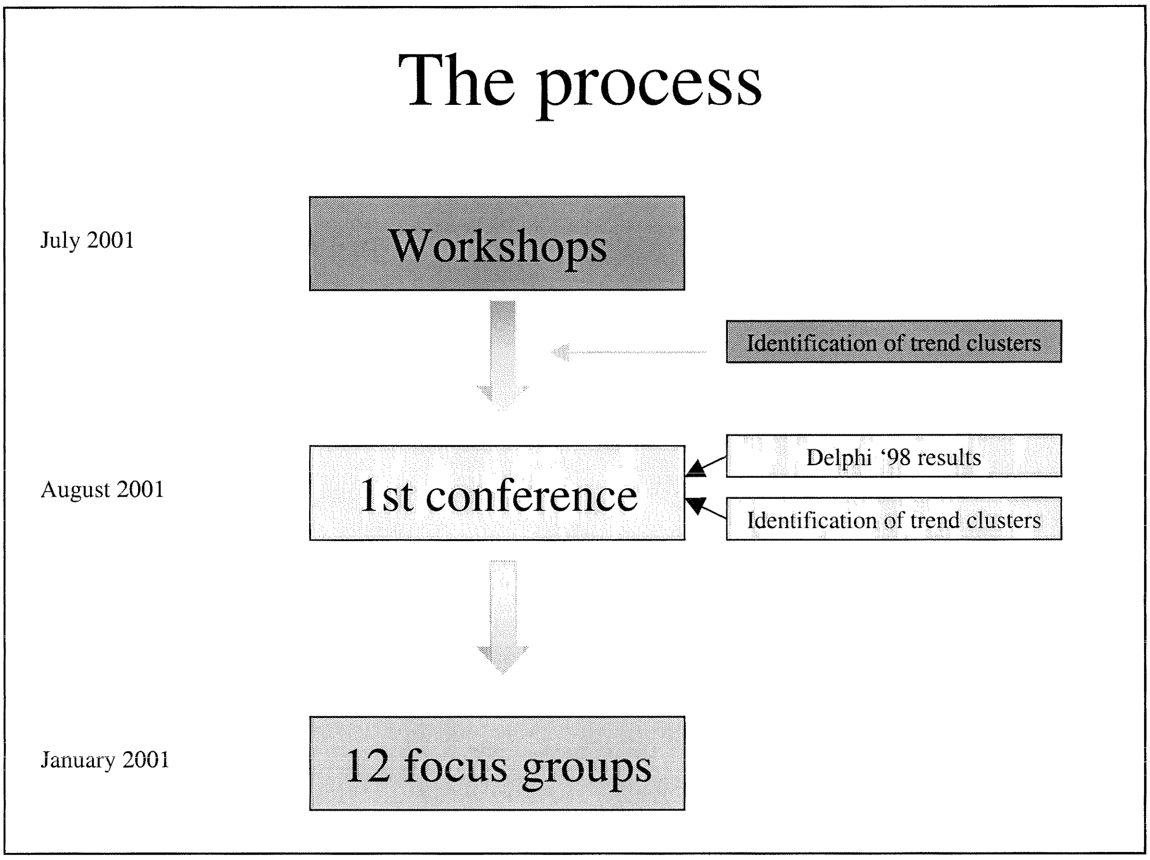
A consortium of four institutions won the call for tender and is responsible for the process management. The institutions have different functions: IFOK, the Institute for Organisational Communication in Bensheim and Berlin, is responsible for the overall process management and flow of communication; ISI, the Fraunhofer Institute for Systems and Innovation Research in Karlsruhe, provides methodological know-how and international experience, acting as a scientific consultant; IZT, the Institute for Future Studies and Technology Assessment in Berlin, with specific knowledge in futures methodologies, organises e.g. scenario workshops and future workshops (*Zukunftswerkstätten*). A specialised company takes care of public relations on scientific information. The VDI/VDE Technology Centre in Berlin, Teltow, provides and organises technological expertise.

The process started with *workshops* in early summer 2001 (exhibit 1) and is still running. Actors from industry, science, the media, etc., were invited. These persons were selected because of their more broad, general knowledge. They were not supposed to be 'specialists' in the narrow sense. From this first list, a kind of co-nomination process (Nedeva et al., 1996) was conducted identifying about 700 persons at this stage.

Workshop participants were asked what they thought society might look like in the year 2020. This was written in a mind map. The second question was how they thought their own field might develop. Questions concerning the future had to be written down in a kind of brainstorming (not methodologically strict) session. This part of the process was called 'trend collection'. After the workshops, the consortium grouped the identified trends (trend clusters).

As the next step, an '*open space conference*' was organised in Berlin. The purpose of this conference was to establish '*focus groups*' which should then focus on their themes. The cases identified from the above mentioned workshops were mainly accepted and modified, supplemented by information from the Delphi '98 study and several foresight journals. While no new themes were forthcoming it would still have been possible to establish a group on a totally different theme. The groups had to produce 'profiles' of their themes and a sort of competition was organised to write an interesting profile that met a set of given criteria (new theme, societal need orientation, research link etc.).

Exhibit 11: **Selection of Focus group themes**



BMBF wanted to select twelve areas from the focus group's themes to be more thoroughly debated in *Futur*. The ministry organised an in-house workshop with department and division heads, as well as the project management agencies' representatives, in which they were asked to score the thematic areas according to their relevance. A similar process was organised on the Internet: the persons already identified for the initial workshops were also asked to cast their vote; about 200 persons voted. Finally, BMBF selected the twelve groups, taking into account the votes and the views of the ministry's thematic departments (*Fachreferate*). The minister herself had the final decision. The selection covered the following *twelve thematic areas*:

1. The learning society Germany.
2. Organisational models for dealing with knowledge (together with the subject of 'Innovative Structures to Generate, Select and Transfer Knowledge').
3. Sustainable mobility.
4. Progress in medical technology: What is possible, realisable, fair?
5. Natural resources as human environment – ensuring the future by biodiversity and climate research.
6. Intelligent products and systems for the society of tomorrow/ the intelligent product.
7. Life in a networked world: efficient, self-defined, safe.
8. Forward planning and designing work to make life worthwhile ?? in the knowledge society.
9. Consumption (enjoyment), quality, supply – nutrition in the system.
10. Sustainable agroproduction in global responsibility.
11. The promotion of intercultural potentials.
12. Decentralisation – strategy for sustainable economies/industries and life.

In parallel, 'future workshops' (*Zukunftswerkstätten*) were conducted in November and December 2001 exploring five thematic fields: 1. Future of health and well-being. 2. Balancing work and life. 3. Ageing in a sustainable society. 4. Urban conglomerations of tomorrow. 5. Learning worlds of the future. 'Future workshops' are a method used for developing 'wishful' (normative) futures in an open atmosphere without formal hierarchies, and for looking at their implementation potential. Methods for visualising, brainstorming and creativity stimulation were applied.

The 'focus groups', conceptualised as a kind of participatory, thematic panel, started their work in January 2002. They were provided with background material in advance. For this – as well as for 'virtual', moderated meetings – a *workspace in the Internet* was opened up as a joint working platform. The focus groups have been assigned the task of re-focusing their topic according to a pragmatic set of criteria, and thereby identifying the perspectives, driving factors and frame conditions of their area. Consistent scenarios had to be written on the outcomes. The scenarios, highlighted as 'pictures of the future', are to be communicated to the public via various media (exhibit 2). Using these scenarios, BMBF intends to formulate normative *leading visions* with relation to science, research, technology and education (the tasks of BMBF) (exhibit 3). They are intended to serve BMBF as normative objectives to be followed, and as priorities to be set in funding programmes.

Exhibit 12: **Development of scenarios**

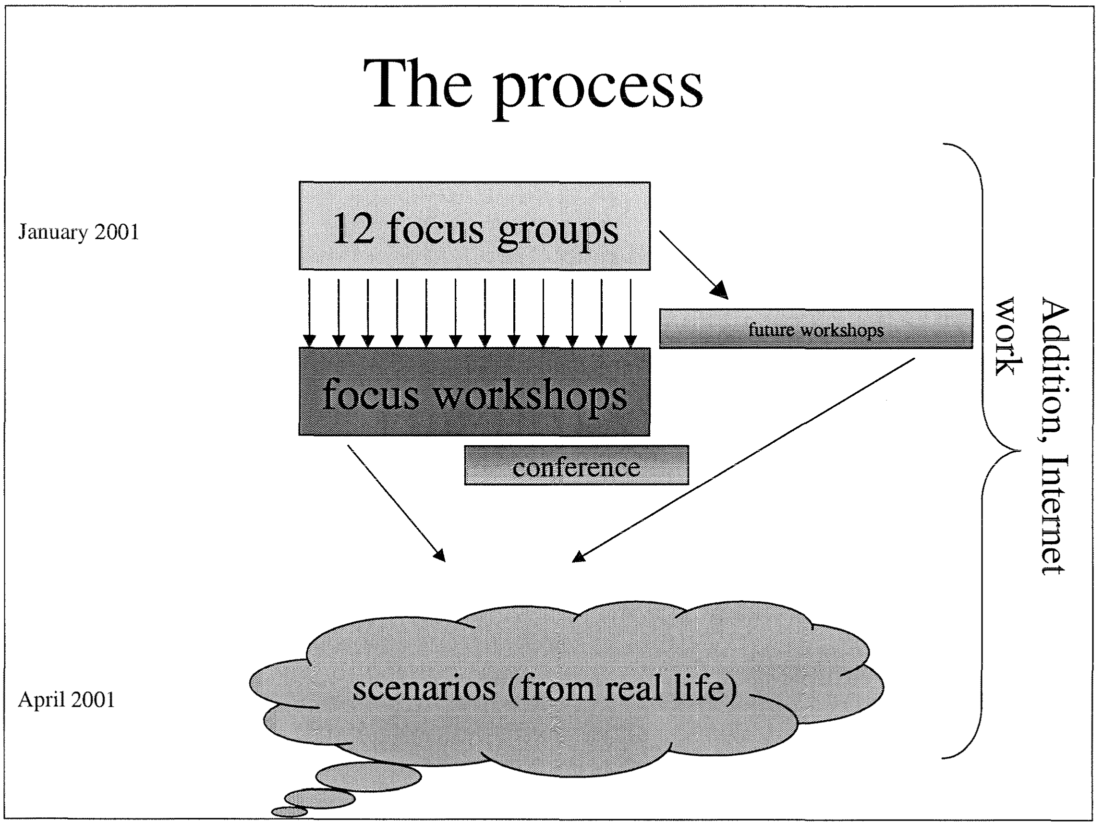
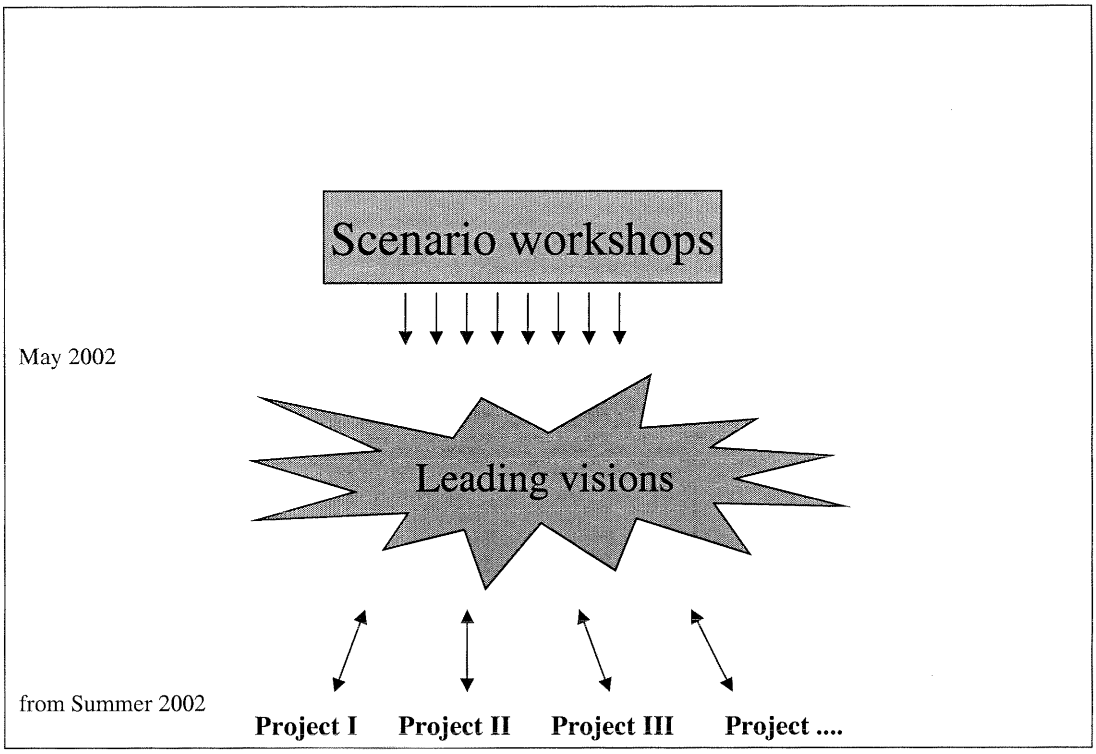


Exhibit 13: **From scenarios to leading visions**



5. The relationship with other instruments

The *traditional mechanisms of priority-setting* for research funding are still in place: funding topics are generated in a bottom-up manner, channelled by the BMBF's thematic divisions and departments, maintaining close relationships with 'the research world', both in academia and industry. 'Priority-setting' occurs as a result of an (undeclared) intra-ministerial competition for funds between themes which had been absorbed by BMBF's departments from the networks they are embedded in. This is a ambivalent procedure: on the one hand it guarantees close interaction with the 'real world' of science and technology; on the other it is inherently fostering structural conservatism by excluding newcomers from the established networks and communication processes.; i.e. the traditional mechanism of priority-setting for research funding is favouring *incremental* rather than radical change.

Since this mechanism has not been formalised completely, it cannot be 'stopped' by a simple decision – quite the opposite may happen: '*Futur*'-generated ideas might fail to be transferred into funding programmes because powerful, traditional actors inside BMBF and in the research system do not accept them. Against this background, it would be a success already if the 'old-boys-networks' would at least latch onto *Futur*-generated ideas by claiming that they were the actual originators and owners of a new theme. There is a certain chance for this latter option, since as a procedure *Futur* – differing from the Delphi studies –is more closely interwoven with the traditional prioritisation channels.

6. Evaluation Questions

6.1. Contribution to the five functions as specified in section 3.

The *Futur* process can certainly be defined as an instrument for systemic policy making. In terms of the five functions described in section 3 we might conclude that *Futur* intends to (1) 'manage interfaces', i.e. attempt to build bridges between genuine science and technology actors, societal groups, and policy makers, to stimulate debate, and to articulate demand for future innovation-related research; furthermore, *Futur* is intended to contribute to (2) a 're-organisation of innovation systems' by facilitating *Neue Kombinationen* through organised discourse, alignment, and consensus on new research funding priorities, not least by trying to escape traditional lock-in situations in research policy making; thereby *Futur* offers a (3) 'platform for learning and experimenting' using workshops, 'open space conferences', etc.; in parallel, as a foresight process *Futur* intends to contribute to an (4) 'infrastructure for strategic intelligence' by linking heterogeneous intelligence sources (Delphi studies; results of other foresight exercises; documentation and communication of *Futur*-results, etc.) accessible for all relevant actors, thus performing clearing house functions...), and also developing strategic information tailored to the needs of BMBF's policy makers. Last but not least, *Futur* definitely strives for (5) 'stimulating the demand articulation as well as strategy and vision development' since this is precisely what the different *Futur* instruments such as workshops, conferences, Internet platform etc. are designed for.

6.2 Effectiveness, impact

The *Futur* process is still running, and for the purposes of this report it is as yet too early for an assessment of its effectiveness and the impact of the new approach to research policy priority-setting. In the course of 2002 an evaluation will be conducted by an independent international foresight expert panel 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 in Germany, i.e. the BMBF, the *Deutsche Forschungsgemeinschaft*, universities or non-university research institutions. As in the previous foresight exercises, it must be stated that it is difficult to make people think about the future, especially the longer-term future. People are so much involved in present-day thinking and present-day problems that they tend to prolong the current problems into the future. Therefore, the methodologies used have to take into account that people have to be motivated to be more 'Utopian'. (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 this also happen in the event of a change of government after the general elections in autumn 2002?

6.3 Efficiency, price/quality ratio

The *Futur* process is relatively costly: the managing Consortium employs a considerable number of staff, and the cost of conferences, workshops, including the travelling expenses of the participants, amount to a considerable financial investment. The efficiency is difficult to measure since there is no immediately comparable procedure. Basically, one would have to 'calculate' the direct and indirect cost of the traditional priority-setting procedure, including the cost of missing important new research themes.

6.4 Barriers and incentives

To start with, the *incentives* provided by *Futur*: obviously, the participatory approach – basically – is an incentive to many people and institutions normally not involved in research policy priority-setting; the number of participants in the various *Futur* activities (above 2000 so far) gives some evidence of its attractiveness (nevertheless, the last German Delphi exercise mobilised a higher number of people).

There are also several serious *barriers* to *Futur*'s success: (1) the traditional research policy priority-setting mechanism is still in place, and it is not yet clear to what extent *Futur* will contribute towards changing this. (2) There is a conceptual and procedural tension (if not: contradiction) between *Futur*'s 'open-endedness' on the one hand and its mission to come up quite quickly with implementable policy priorities on the other. (3) The selection procedures discriminating ideas in the 'ocean of desirable future research', put forward by *Futur* participants, is not sufficiently transparent and structured as yet. Participants fail to fully understand who does what with their ideas, and for which reasons. Which role does the ministry play in the selection process? What is the intervention power of the *Innovationsbeirat*? How much authority is left to the *Futur* process as such?

6.5 The government's role

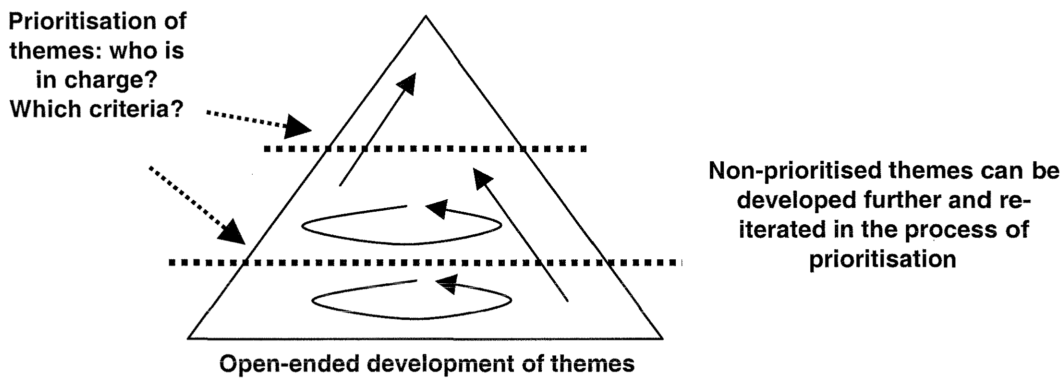
Government's role with respect to *Futur* is ambiguous: (1) the research ministry is the owner of the process; the minister committed herself to support *Futur*; ie. the process basically enjoys strong political backing. (2) On the other hand, there has been some considerable scepticism and even resistance within the ministerial body against *Futur*'s novel and unconventional approach. (3) Those in charge (and in favour) of the process in the ministry have proven an ambiguous perception of their role within the process – wavering between an authoritative 'leader' and an interested 'facilitator'.

6.6 Suggestions for improvement

There are two basic suggestions for improvement: (1) The tension between *Futur*'s 'open-endedness' on the one hand and its mission to come up quite quickly with implementable policy priorities should be reduced, not least by putting more clearly in parallel the two missions. (2) The second suggestion is closely related to the first one:

until now the criteria and procedures of selecting themes for development into *Leitvisionen* is not sufficiently clear and transparent (see exhibit 4).

Exhibit 14: ***Futur* process: selection for prioritisation of research funding themes**



Beyond, during the course of the first year of *Futur,* a number of aspects emerged that could be taken into account to further improve the process:

- Foresight processes are very much linked to the time they are conducted in. They represent the '*Zeitgeist*'. Whereas ten years ago, environmental issues were regarded as the most important ones, now, after the terrorist attacks in the USA, security is more at the forefront, and since the BSE crisis in Europe, questions about agriculture and food security have also arisen. Therefore, continuing foresight processes are important in that questions that can be forgotten because of current debates are still brought up again after some time.
- The selection of participants is crucial. A sort of co-nomination was conducted in *Futur*. Yet this was not enough to obtain a representative sample from the actor groups wanted. Most persons made their recommendations within their own community. It is therefore essential that the organisers add names from 'neutral' data bases.
- For the focus groups, more special knowledge is necessary. Therefore, it is not possible to rely on co-nomination processes only; experts must also be asked to participate in order to dig into the necessary depth of the theme. In spite of all the previous criticism, experts are still needed in foresight processes. *Futur* is at this stage at the end of 2001.
- There is a certain amount of tension between digging into detail – for which expertise is necessary – and the task of limiting expertise in favour of broader participation and keeping the process open.
- Neutrality of the organisers is important. Therefore, the consortium was asked to conduct the process instead of BMBF itself.
- While lobbyism does occur, it should be avoided. There always seems to be groups which fear losing their present advantages or stakes, and there are always 'old boys networks' that attempt to influence political processes like *Futur*. For the organisers it is sometimes difficult to detect or identify them, but everyone organising a foresight process should be aware of this problem and at least try to avoid it by involving participants identified from different sources and by applying methodologies that single out these problems (Delphi, with its anonymity, is a good foresight method in this respect).
- The media cannot be influenced but must be informed as precisely as possible in order not to convey 'incorrect' facts. Negative reports in the press can sometimes be better than no publicity at all and stimulates the curiosity of people to look on the Internet.
- Time is needed to prepare and conduct workshops and working groups. Adequate time should be planned in order to provide the necessary background material and be able to summarise it in the proper way. In

Futur, this time is very short, maybe too short to prepare things in an optimal fashion. At least two years should be scheduled for such a process.

To conclude:

Futur	**LEGITIMATION**		**TYPE OF KNOWLEDGE***				**SYSTEM LEVEL**		**TYPE OF SUPPORT**		**NATURE OF PROBLEM**	
	Market failures	**System failures**	**β**	**γ**	**βγ**	**Tacit?**	**Organi-sation**	**System**	**Organi-sation**	**Sys-tem**	**Opera tional**	**Strate-gic**
	+	+++	+	+	+++	+++	+	+++	++	+++	+	+++

* **β** = science
γ = social sciences
Bγ = science / social science

Futur	Primary goal	Client	Content	Process	System
	Participatory generation of future themes for innovation-oriented research funding. Prioritisation of themes for funding by the national research ministry.	A 'quadrangle': government, in particular the research ministry, private enterprises, knowledge institutes and social groups.	Foresight; visions; strategic intelligence; Strategies.	Participatory mobilisation of knowledge and concerns about future research needed, through a variety of communicative and analytical procedures.	In case of success a serious contribution to system change: new demand driven ways of policy-prioritisation; Developing infrastructure strategic intelligence.

Summary and initial analysis

The matrix below presents a major overview of the four case studies.

GOAL
METHODS
FUNCTIONS
IMPACT
PORTFOLIO
COMMENTS

INNONET
To formulate options and priorities for mid and long-term research in the agricultural sector on the basis of a thorough exploration of scientific and societal trends and developments
Foresight
Network (de-) construction
Workshops
Scenarios
Mgt process strategy development
Potential impact:
1: +
2: +++
(creative destruction problem?)
3: ++
(implementation problem?)
4: +++
(integration in wider network problem)
5. ++?
(best practices not yet available)
Impact of new Network (since 2000) difficult to evaluate.
Predecessor positive impact on coherence, strategy and vision development in heterogeneous sector. Too conservative, avoiding controversial issues, implementation results weak. Not sure whether or not the latter problem has been solved.

Potentially high impact on financial (allocating R&D-resources), diffusion (networks facilitate transfer of people and knowledge), managerial (development and implementation of vision and strategy)

Further in-depth evaluation necessary to really assess impact.
Predecessor, NRLO, institutionalised by law 1987, explicit focus on tuning research and society.
Innonet since 2000. Heavy focus on systems innovations and network building (*Neue Kombinationen* and creative destruction).

GOAL
METHODS
FUNCTIONS
IMPACT
PORTFOLIO
COMMENTS

DTO

To convince policy makers that technology can further sustainable development and,
to influence technology developers to include sustainability in their list of design criteria
Back-casting
Participatory methods
Transition philosophy
Stakeholder analysis
Vision development (should be developed further)
Demonstration, illustration projects
Special 'anchorage' programme

1: +?
(durable?)
2: ++?
(durable?, little attention for creative destruction)
3: ++
4: not in a structural way
5: +++

Raising awareness of technology and sustainability out of square
Special 'anchorage' programme building effective links with educational system
Bureau provides active support for those who want to learn
Establishment of NIDO (Netherlands organisation for sustainable development)
Insights DTO used in INNONET
Some impact on financial (allocating R&D-resources), diffusion (illustration projects facilitate communication between various actors), managerial (long term strategy, development of green products & services)

Further in-depth evaluation necessary to really assess impact.
In total 5-6 years, 5 ministries involved.
5 areas: food, transport, water, housing, chemistry
Widely accepted criteria for sustainability necessary
What is necessary is a motor to start up programmes like DTO.

GOAL
METHODS
FUNCTIONS
IMPACT
PORTFOLIO
COMMENTS

CLUSTERS
To help actors involved in innovation to overcome system imperfections, particularly to stimulate interaction within the system.

Very context specific
Mapping
Cluster platforms
Tax and regulation reform
Networking programmes
Brokerage training
Public procurement for consortia
Cluster-specific information and technology centres
Technology circles
Foresight
Platforms to explore market opportunities
Subsidise collaborative R&D and technology transfer
Support start-up of frms

Considerable impact on other instruments in the portfolio. Financial (impact on money-flows between firms, because of their strategic dimensi
- provide a context and guidelines for allocating R&D-investments), diffusion (impact on interactions between firms and knowledge institution
on the flows of knowledge and people between actors), managerial (improve the technology- absorptive capacity of firms.
More important are the strong relations with policies and policy instruments outside the innovation domain.
1: +++
2: +++
3: +++
First three functions are at the heart of cluster policies.
4: +
5: +
Impact not yet adequately evaluated. Major impact expected in line with the first three functions.
No systematic evaluation up to now
OECD recently published two standard volumes on the cluster approach
Clusters are reduced-form innovation systems
Crucial trade-off between favouring existing clusters and identifying and facilitating emerging innovative clusters
A new breed of policy makers necessary to implement cluster policies

GOAL
METHODS
FUNCTIONS
IMPACT
PORTFOLIO
COMMENTS

FUTUR
Participatory generation of future themes for innovation-oriented research funding, not at least to bypass 'old boys networks'.
Prioritisation of themes for funding by the national research ministry

Participatory mobilisation of many actors from science, industry, societal organisations (in particular younger people), stimulating them to put
forward their knowledge and concerns about future research needed, through a variety of communicative (workshops, conferences, web-based

platform) and analytical procedures
There is also an attempt to inter-link this participatory approach with intra-ministerial procedures of decision making.

Intended functionality:
1: ++
2: ++
3: +++
4: ++
5: +++

Process is still running, too early as yet for an assessment of its effectiveness and the impact on research policy priority-setting. An evaluation
be conducted in 2002.
Two key questions will have a decisive impact on *Futur*'s success: (1) How truly 'innovative' are the *Futur*-generated thematic areas for resear
funding – compared to already existing funding activities? (2) Will the ministry take up and implement the *Futur*-generated *Leitvisionen*, and
equip it with substantial funds?

Potential impact on R&D funding; potential increase of legitimatisation of public research policies as demand driven initiatives

There are two basic issues: (1) The tension between *Futur*'s 'open-endedness' on the one hand and its mission to come up quite quickly with implementable policy priorities (2.) Up to now the criteria and procedures of selecting themes for developing them into *Leitvisionen* (leading visions for funding programmes) is not sufficiently clear and transparent

Given this overview, and taking into account the lack of an in-depth analysis, the following, initial observations can be made:

1. Meanwhile a sufficient number of instruments can be characterised as more or less 'systemic'; instruments from which we can learn. Most of them cover more than 50% of the five functions.
2. There is a tremendous difference in how these instruments attempt to contribute to these functions, even within the context of one specific systemic instrument.
3. Up to now, these instruments have not been analysed thoroughly enough, and there hardly any systematic monitoring and evaluation procedures in place to facilitate this analysis.
4. As a consequence, there is a great deal of uncertainty as to the nature, the magnitude and the structural character of the impact of these instruments.
5. Observation 4 also accounts for the many instruments used within the context of the systemic instrument such as, for instance, techniques for the development of scenarios and visions, back-casting and technology circles.
6. What does seem to be clear, however, is that all systemic instruments analysed in this report have a positive impact on the other instruments in the portfolio. They facilitate the use of these instruments and/or improve their performance.
7. However, up to now this potential to reinforce the efficiency and effectiveness of other instruments in the portfolio has deliberately not been exploited because the focus has generally been on individual instruments and not on the portfolio itself. The performance of innovation policy making can be enhanced by improving the ability to manage the portfolio of instruments instead of focusing on individual instruments.
8. Up to now the emergence, functioning and follow-up of these instruments often depends on '*ad hoc*' decision making and/or the efforts/initiatives of visionary individuals. There are no mechanisms embedded in innovation systems that trigger the emergence and use of these instruments when necessary. To certain extent, the cluster approach might be an exception here.

Apart from the problems related to monitoring, evaluating and analysing the impact of these instruments, the most important problems policy makers dealing with the further development of systemic instruments must face are:

- how to organise effective learning and experimenting;
- how to ensure that these instruments achieve structural, long-lasting results;
- the availability of actors with the right attitude and skills;
- creative destruction of systems, institutions and relations that no longer fit the new demands.

6 Conclusions and questions for further research

Introduction

In this section we will try to answer the questions formulated in section 1, starting with the first two which dealt with the co-evolution of practice, theory and policy and early experiences with systemic instruments '*avant la lettre*'. Subsequently, we devote attention to two types of systemic instruments which are the subject of projects conducted within the framework of the Strata programme of the European Commission's Directorate General for Research. The main aspects of concern here being 'science shops' and 'public private partnerships between the world of science and the economy'. In the next paragraph we then go deeper into the role government plays in the further development and facilitation of systemic instruments. The report is concluded with an agenda for further research.

The first 2 research questions

1.a What, over the last three decades, have been the *major trends* in innovation processes, innovation systems and intervention strategies, including governmental innovation policies?

and,

1.b What are the *consequences* of these trends for the functions required of policy instruments and for the composition of the policy instruments portfolio?

The analysis results:

- The *innovation system* serves as the frame of reference in this report; our point of departure was that innovation processes and innovation systems (practice), innovation theory and interventions are linked by different types of learning in a *co-evolutionary process*.

- Over the last decade *three developments* have resulted from this co-evolutionary process.

  1: The end of the linear model of innovation.
  Innovation is seen as the result of social and economic processes with multiple feedback loops in which many actors play a role. Specifically the users often play an important role, both during the design phase and the use phase. Major reasons for this are: users wish to have a better grip on innovation processes, and the producers of innovations are desirous of the broad societal acceptance of their innovations, wanting access to the tacit knowledge and creative potential of the users.

  2: The emergence of the systems perspective.
  The starting point of the innovation systems approach is that organisations are not innovating in isolation but within the context of an innovation system. As a consequence, their performance is dependent on the quality of that system, especially on the quality of the subsystems (R&D, users, intermediary and supportive infrastructure) and, maybe even more so, on the mutual tuning of these subsystems. Another consequence of the systems approach is that more – very heterogeneous actors, often at very different levels and operating in various arenas – are involved in (the management of) innovation processes (Kuhlmann et al., 1999). A further characteristic of the systems approach is the concept of 'path dependency'. This concept underlines the specificity of innovation systems yet again and, moreover, the concept stresses that systems do have a memory that should be taken into account when studying the dynamics of the system. Another trend that must be mentioned at this point concerns the growing *fuzziness* of innovation systems. Starting in the mid-eighties, innovation systems developed from systems with discrete, loosely coupled entities into systems with strongly interlinked entities with rather fuzzy boundaries.

  3. The increasing awareness of inherent uncertainty and – as a consequence of this awareness – the growing importance of learning and organising learning.
  Innovation is not a question of optimising performance under neo-classical conditions. Uncertainty is inherent to innovation for several reasons. The fundamental sources of this uncertainty relate to the

complexity of innovation systems and to the 'man-made' character of innovation; because innovation is the work of man, it never can be predicted. Actors involved in innovation processes do not possess flawless information, and they must function under conditions of bounded rationality. Technology does not offer itself as ready-made packages, but far more as opportunities. It is up to the users to trace these opportunities, make clear what they mean for them, assess the implications of implementation and, finally, make a selection and develop plans to make sure that the selected opportunities are indeed turned into successful innovations. Having said that it will be clear that innovation is not a matter of optimising performance under 'neo classical' conditions, but a process of trial and error in which various types of actors play an important role.

- These trends have important *consequences for policy makers and other actors involved* in innovation processes. The most important ones are:
  - the increasing need to manage interfaces between the users and producers of innovations;
  - the need to embed innovation policies in a broader socio-economic context;
  - that innovation polices should no longer focus exclusively on market failures, but also on system imperfections;
  - a reduction of uncertainty by providing actors with the information they need to develop and implement their strategies;
  - a reduction of uncertainty by providing actors with instruments, facilities and environments for experimenting and learning.

- More precisely these trends ask for instruments that fulfil the following *5 functions*:

Management of interfaces
This management not only aims at transferring knowledge, but also at building bridges and stimulating the debate. Furthermore, the management of interfaces is not limited to bilateral contacts but also focuses on chains and networks at system level.

Building and organising (innovation-) systems
Construction (*Neue Kombinationen*) and deconstruction (creative destruction) of systems, initiation and organisation of discourse and alignment, consensus. Also the management of complex systems, the prevention of lock-in, identification and the facilitation of prime movers, ensuring that all relevant actors are involved, are part of this function.

Providing a platform for learning and experimenting
Create conditions for various forms of learning such as: learning by doing, learning by using, learning by interacting and learning at system level (= contribute to the added value of the whole system).

Providing an infrastructure for strategic intelligence
Identify sources (Technology Assessment, Foresight, Evaluation, Bench Marking) build links between sources, improve accessibility for all relevant actors (Clearing House) and encourage development of the ability to produce strategic information tailored to the needs of the actors involved.

Stimulating demand articulation, strategy and vision development
Stimulate and facilitate the search for possible applications, develop instruments that support discourse, vision and strategy development .

2.a What were the (initial) *experiences* with instruments fulfilling (a part of) the functions mentioned in question 1.b available in terms of impact, barriers, incentives and best practices?

and,

2.b To what extent can the experiences and *best practices* related to these instruments be imitated by other countries given the specificities of innovation systems and differences regarding the development stage of governmental innovation polices?

The analysis results:

- In line with the historical development of innovation practice, theory and intervention, we can classify the most frequently used innovation *policy instruments into three categories*: financial instruments (tax incentives, R&D subsidies), instruments aiming to stimulate the diffusion of knowledge (innovation centres, mobility schemes) and managerial instruments providing firms with assistance during their innovative efforts. Financial instruments still dominate the portfolio of policy-instruments very heavily.

- These three types of instruments only *partially cover the five systemic functions* mentioned in the foregoing. The major reason for this is the observation that the first three types of instruments are able to cope with the trends analysed in the foregoing section in a very marginal way only. They still take the individual organisation, usually the business enterprise, as the unit of analysis, hardly play a role as system builder and system organiser, do not give much attention to learning processes, platforms for experimentation, tailor-made strategic intelligence, and most of the time they focus largely on the private sector and far less on the public sector and public-private alliances. Consequently, focusing on the five functions, there is a need for a fourth type of instrument: the *systemic instruments*.

- It should be stressed here that it is not the intention for *'systemic instruments'* to *'take over'* the role of the other instruments but rather to try to complement the other instruments, and in doing so bring in more balance in the portfolio. This means that they often improve the efficiency and effectiveness or even reshape already existing instruments.

- The *development of systemic instruments does not need to start from scratch*. The three other types of instruments cover part of the systemic functions. Furthermore over the last decade some systemic instruments '*avant la lettre*' were developed and implemented. Drawing final conclusions regarding these instruments in terms of content, process and impact is difficult for three reasons:
  - the time to collect relevant information on the performance and impact of the instruments is too short. Not only are the instruments from the last decade, but because their major goal is to induce systemic changes their impact only can be assessed after a longer period of time;
  - no systematic and in-depth analyses of these instruments are available;
  - the main reason for the foregoing is that the authors of this paper are unaware of a systematic and integrated monitoring and evaluation procedure being anticipated for any of the instruments.

- Having said that, some *preliminary observations* can be made on the basis of our initial analysis:

  1. Meanwhile there are a sufficient number of instruments that can be characterised as more or less 'systemic' from which we can learn. Most of these instruments cover more than 50% of the five functions.
  2. There is a huge difference in the way these instruments try to contribute to these functions, even within the context of a single, specific systemic instrument.
  3. Up to now these instruments have not been analysed thoroughly; there are also hardly any systematic monitoring and evaluation procedures to facilitate this analysis.
  4. In consequence, there is a great deal of uncertainty as to the nature and the magnitude and the structural character of the impact of these instruments.
  5. Observation 4 also accounts for the many instruments used *within* the context of the systemic instrument, such as – for instance – techniques for the development of scenarios and visions, back-casting and technology circles.
  6. What does seem to be clear, however, is that all systemic instruments analysed in this report have a positive impact on the other instruments in the portfolio. They facilitate the use of these instruments and/or improve their performance.
  7. Up to now however this potential to reinforce the efficiency and effectiveness of other instruments in the portfolio has deliberately not been exploited because the focus is generally on individual instruments and not on the portfolio itself. The performance of innovation policy making can be enhanced by improving the capacity to manage the portfolio of instruments instead of focusing on the individual instruments.[39]
  8. To date, the emergence, functioning and follow up of these instruments often depends on '*ad hoc*' decision making and/or the efforts/initiatives of visionary individuals. There are no mechanisms

[39] Recent evaluation of the Dutch innovation policy underlines this observation. Fragmentation is, apart from a lack of structural evaluation, one of the major flaws of the Dutch innovation policy (the so called 'IBO-report on Innovation policy' will be available at the end of april/beginning of may)

embedded in innovation systems that trigger the emergence and use of these instruments when necessary. The cluster approach, up to certain extent, might be an exception.

9. Apart from the problems related to monitoring, evaluating and analysing the impact of these instruments, the most important problems policy makers dealing with the further development of systemic instruments have to face are:
   - how to organise effective learning and experimenting;
   - how to ensure that these instruments achieve structural, long-lasting results;
   - the availability of actors with the right attitude and appropriate skills;
   - creative destruction of systems, institutions and relations that no longer meet the new demands.

- There are two sides to the coin with regard to the aspect of *transferability* of systemic instruments from one innovation system to another. On the one hand, systemic instruments are highly context specific for the following reasons:
  - In order for them to be effective, systemic instruments should be in line with the characteristics of the innovation system. As we saw in the foregoing, each innovation system went through its own historic development (path dependency) and will therefore differ – sometimes quite considerably – from other innovation systems. In consequence, the systemic instruments, their goals and the way in which they are implemented, will also differ from one innovation system to another.
  - Systemic instruments do not provide ready-made solutions. Quite often they only create the conditions that facilitate learning processes. The support provided by systemic instruments is also often a process of learning by doing and learning by interacting, and is thus highly context specific and difficult to transfer.
  - The innovation systems of knowledge-intensive economies can vary considerably as was stated in the foregoing. And yet experiences from one innovation system can often serve as a source of inspiration for other innovation systems because – both being a part of knowledge-intensive economies – they often face the same types of problems and challenges. This 'potential for inspiration' however is far less when countries find themselves in a different phase of economic development, reflected in economic structures and related innovation systems, which are confronted with problems and challenges of a (completely) different type compared to those of the knowledge-based economies. In this case, the possibilities for transferability will be even fewer. The many fruitless attempts to transfer experiences with innovation processes in the agricultural sector to the industrial sector may serve as an example of this phenomenon.

The conclusion from the foregoing is that the transferability of systemic instruments and experiences regarding their implementation is not self evident. This conclusion is also supported by the results of the Strata Scipas and Interacts projects on science shops and the Strata Coveseco project on public private partnerships between the world of science and the economy. The Scipas project clearly shows that, although the Dutch science shops acted as a source of inspiration for many of the other science shops, all science shops ultimately developed their own institutional setting and working method. From the country studies of the Covoseco project, particularly from the US case study (Shapira, 2002), it appears that even within one innovation system public private partnerships, in order for them to be effective, must be tailored carefully to the needs and characteristics of specific situations. Given all this variety and context dependency, the concept of 'best practice', quite popular in circles of policy-makers acting at a supra-national level, looses something of its usefulness (and maybe some of its glamour).

Having said this, we also wish to point out the other side of the coin. Although the use of instruments and experiences used in contexts other than those for which they were developed should be handled with care, this does not mean that we should stop trying to learn from one another. Four options apply here in particular:
.. it goes without saying that experiences from one innovation system can serve as an important source of inspiration for actors in other innovation systems. This will be even more the case if those innovation systems do not differ too much from each other;
. studies in which deliberate attempts are made to collect analyses and experiences from different innovation systems and integrate them in a comparative, supra-national whole, are very useful too. Bench-marking studies and supra-national foresight studies (for instance a EU Delphi) are examples. To date, this sort of study is very scarce.
. part of the 'content component' of systemic instruments is relatively context independent. As an example we refer here to the 'technological component' of foresight and technology assessment studies;

. part of the 'process component' of systemic instruments (the nuts and bolts, not the application) are occasionally context independent. The basic schemes of consensus development conferences, science courts and scenario workshops can be mentioned here.

However, in order to exploit this 'learning potential', an infrastructure should be reinforced or even created to support these learning processes. In the final paragraph of this section (research agenda) we propose the development of two networks. One of these networks, the network for distributed strategic intelligence, could provide the infrastructure for facilitating the identification of and access to relevant content. The other network, the policy laboratory network, fulfils a similar function with regard to processes and instruments.

Intermezzo: public private partnerships and science shops

Before we turn to the role of government in furthering systemic instruments we first wish to go deeper into two specific instruments that are the subject of projects within the framework of the Strata programme. The subject of research in the Strata-Covoseco programme is public private partnerships between the world of science and the economy, and science shops in the Strata-Scipas programme. Both focus on strengthening interfaces (science-economy, universities-societal groups) and can thus be seen as systemic instruments.
In the Covoseco project (Faroult, 2002) an analysis in nine countries shows a growing need for public private partnerships (PPP) in the area of research and technology and the economy. In the study it is concluded that while PPPs are an old instrument, they are often limited to the short term, one-to-one interaction (mobility, technology transfer) and to commercial goals, for instance the commercialisation of university research results (Faroult, 2002). The report stresses that nowadays there is a particular need for PPPs which have a long-term orientation, involve clusters of firms and research organisations, and play a role in the organisation of the innovation system and strategy development within the system. A growing need for more systemic instruments can be derived from this. This conclusion is further underlined by a second conclusion from almost all countries covered in the Covoseco study that, to date, evaluation of PPPs has hardly been organised on a structural basis and that there is a need to improve the evaluative function. According to the German case study (Moon, 2002), the evaluation function should be organised as a pro-active process being an integral part of the innovation system and playing an important role in providing researchers, innovators and users with feedback. Formulated in this way, the evaluation function has many characteristics of a systemic instrument fulfilling a role in the management of interfaces and facilitating learning. The country studies were only the first phase of the Covoseco project that should provide the basis for the development of a process-oriented self-evaluation tool (empowerment evaluation tool) that should help monitor and improve PPPs. The results of this study are very promising in the context of the further development of systemic instruments.

The development and further reinforcement of science shops are put central in the Scipas project. The Science Shops movement originated in the Netherlands in the early 1970s with the main goal of making university research more accessible to societal groups (Scipas, 2002):

A Science Shop provides independent, participatory research support in response to concerns experienced by civil society.

Science Shops wish to articulate and answer the questions that exist among the less powerful parties of civil society and to improve their access to university research. The focus is on societal goals such as sustainable development. In this way, the Science Shop movement wanted to improve the democratic level of decision making on science and technology, and at the same time increase the societal relevance of university research. They aim specifically at (Scipas, 2002):

- *providing society with knowledge and skills by means of research and education at a low cost;*
- *promoting society's access to and influence on science;*
- *creating just and supportive networks between the world of science and civil society;*
- *enhancing the understanding of policy makers and education and research institutions for the research needs of civil society;*
- *improving the skills and knowledge of students and researchers and thus to enable them to interact with civil society.*

Formulated it this way, Science Shops can be seen as systemic instruments '*avant la lettre*'. Over the last 30 years, the Science Shop concept has spread across the entire world.

Over the last decade, the position of Science Shops has deteriorated. In the Scipas project the decrease of university funding, students who have to work harder and consequently have less time to spend on the Science Shops, too little recognition of the work of the – very motivated – Science Shops fellow workers, sub-critical capacity and the rapid growth of university contract research are mentioned as major causes of this situation. The Scipas programme is intended to look out for opportunities to improve this situation. Major routes along which Scipas tries to realise this are the establishment of an international network of Science Shops (the Living Network), improvement of the integration of Science Shop activities and university curricula and research programmes, training programmes, an international Science Shop magazine and a public Science Shops Internet database. Scipas hopes that this will improve the efficiency and efficacy (synergy, economies of scale), dissemination of results, visibility, accessibility; that it will improve quality control, speed up learning processes and (as a result of the improved interface between universities and society) improve the capability of Science Shops to act in a pro-active fashion.
The majority of these initiatives focus on reinforcing the Science Shop infrastructure. The question however can be raised whether this really is the answer to the problems facing the Science Shops. This question is not easy to answer because the Scipas reports do not provide a thorough enough analysis of either the nature of the problem or the causes. While we do not claim to have the ultimate solution here, we would like to make some comments on these problems and causes because we think that while they certainly do point towards solutions that could include a reinforcement of the infrastructure, they go much further since they also show the necessity of a fundamental strategic debate on the position of the Science Shops in the actual innovation arena before conclusions can be drawn as to any potential action.

In our view, the major problem of the Science shops is that they turned from forerunners into laggards. Or in other words: it seems that Science Shops have meanwhile become somewhat isolated from the main stream debate on innovation practice, innovation theory and innovation policy. Taking the Dutch situation as an example – after all, the Netherlands was the cradle of the Science Shops – it must be concluded that Science Shops play no active role in the debate on innovation policies, innovation theory (not even when 'real' Science Shop themes such as technology assessment, strategic niche management and user involvement are at stake), and in those areas were societal problems do call for new research initiatives they are often by-passed by initiatives such as the DTO programme (the successor of DTO), NIDO (Netherlands Organisation for Sustainable Development) and the organisers of societal debates on for instance genetic engineering and genetically modified food. Furthermore, the Science Shops hardly played a role in the development of the 5-year, multi-disciplinary courses on the integration of science and technology in economy and society as have been developed over the last decade at the three Dutch Universities of Technology and Utrecht University, nor indeed do they play such a role today. Together, these courses attract between 250 and 300 first-year students every year. As far as we can see the same observation must be made with regard to the link between Science Shops and the many university or para-university research groups in the field of innovation and science and technology studies that have emerged over the last 20 years. To conclude, Science Shops failed to achieve a very good link with the co-evolutionary processes sketched in section 1 of this report.

What could be the causes underlying this development? One important explanation is that the driving forces between the Science Shops differed considerably from those behind the emergence of innovation policy at the end of the 1970s and early 1980s. The Science Shops developed in the context of the debate on science policy (OECD, 1971) and the struggle of environmental groups, students and civil rights movements to realise structural changes in the administrative and institutional systems. Improving the democratic level of decision making and sustainability were the key issues in those debates. The driving force behind the genesis of innovation policy – which gave a strong impulse to the further development of innovation theory – was the economic recession in the second half of the 1970s. A major difference from the development of the Science Shops was that the actors participating in this development were far more powerful than those involved in the development of the Science Shops. Furthermore, the number of actors involved in this arena grew steadily over the last two decades (Smits et al., 1995). During this period, the development of innovation policies (defined in the broad sense as the deliberate attempts of all relevant actors involved in innovation processes), innovation theory and innovation made rapid progress. It seems that the actors involved in the Science Shop movement failed to establish an adequate link with these learning processes. This is all the more striking since many of the central themes of the Science Shop movement played an important role in this development. Examples are the involvement of users in innovation processes, the societal acceptance of innovations, dissemination of research results to the wider public, the provision of strategic intelligence such as technology assessment and technology foresight – intended to stimulate demand articulation among all relevant actors –, the issue of how to prevent technologies such as ICT from leading to a split in our societies, the contribution of innovation to a more sustainable society and – more in general – the question how science and technology can better contribute to societal questions and challenges. It is of course rather speculative to provide answers to the question why the

Science Shop movement participated so little in these developments. One suggestion we would like to make is that the arena in which the Science Shops play their role not only distinguishes itself from the innovation policy arena by the type of actors, but also in terms of culture. In a way it looks as if the Science Shops still adhere to the 'two-cultures' model of science and technology from the early 1970s. In those days on the one hand you had the proponents of science and technology and on the other, actors taking a critical stand vis-à-vis these developments. In the innovation policy arena, where in the first instance these two sides were very perceptible, over the years the actors learned that they were all part of the same strategic game in which interests would sometimes coincide and make collaboration necessary, and interests would sometimes conflict, urging a position to be taken at arm's length. It seems that actors of the Science Shop movement preferred to keep their distance from the opponents of the old days. Taking such a position, regular strategic reflection on one's own position in the 'overall' innovation arena is not very likely. In our view, however, this is what the Science Shop movement should do. A critical and strategic reflection on one's own position in the meanwhile drastically changed environment is very necessary to redefine the '*raison d'être*' of the Science Shops. Without a clear view on the mission resulting from this reflection, improving the infra-structural conditions seems to be somewhat premature.

Research question 3: The role of (European) government

The preceding sections gave evidence of a considerable change of governments' role in furthering research and innovation. In fact, political systems and national systems of research and innovation have been co-evolving since the 19th century (if not for longer). The emergence of systemic instruments is thus reflecting both changes in research and innovation (resp. science, economy, society) and in the political system, more in particular: in the political governance of research and innovation. We have seen that innovation requires more interrelationship and interaction between heterogeneous policy agendas, actors, and arenas. As far as public policy gets involved there is a *need for horizontal and systemic policy co-ordination*. This statement is grounded on two basic insights:

(1) The *"instrumentalist" view* of 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, 1974): 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.

(2) Innovation policymaking is only seldom a matter of top-down decision-making and straight-forward implementation; rather it can be modelled as a process of networking between heterogeneous (corporatist) actors representing different societal subsystems. Frequently, policy decisions are negotiated in *multi-actor arenas* and related networks (Marin & Mayntz, 1991) which may stretch over multi-level politico-administrative systems: reaching from regional to transnational responsibilities. Negotiating actors with different responsibilities (policymakers 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) or corporations. Normally, *"state"* authorities in (regional, national, transnational) multi-actor arenas of innovation policy play an important, but normally *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. "Successful" policymaking normally means compromising through "re-framing" of stakeholders' perspectives and joint production of consensus.

Still, nevertheless, the 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 (e.g. Germany, Netherlands, UK ...)
- dominance of "linear model" of innovation in policy approaches (and of related economists as consultants) in many national authorities (e.g. ministries)

- conceptualisation of "innovation policy" as a very specific, narrow field focusing closely on introduction of new technologies in SMEs, IPR or VC issues etc.

In sum, we find many *lock-in actor constellations* and related interest conflicts, within and between involved arenas. Policymakers striving for a successful implementation of systemic instruments are confronted with huge *complexity*: how to manage complex systemic policy instruments?

Jacobsson and Johnson (2000; i.e. their already earlier mentioned 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 (Neue Kombinationen) 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.

With respect to the *European level*, we suggest *two directions of action* that could be taken up by the EU Commission:

(1) In Europe, the emergence of a multi-level governance in the context of the European integration makes the launching of "bridging/systemic" policy approaches even more difficult. For decades now, we are witnessing a co-evolution of regional, national and European policy arenas towards an integration in multi-level, multi-actor systems (Kuhlmann, 2001a; Grande, 2001). All three levels undergo a re-distribution of tasks, thereby experiencing new functional and informational linkages, vertically and horizontally. Initiatives of the "géométrie variable" type have been suggested repeatedly and could soon be implemented (e.g., in a sense, the envisaged "Networks of Excellence" of the 6th Framework Programme could be interpreted as systemic, "géométrie variable" type of instruments). Transferring the Jacobsson and Johnson concept into this European innovation policy arena would mean: while regional or national authorities would continue to improve the competitiveness of "local" innovation systems, the *EU Commission* – instead of running cumbersome own funding programmes – would *"mediate" between the competitors* and "moderate" their conflicts. Public investment in, and regulation of S/T and innovation originate mainly from regional or national initiatives and sources – but it are concerted and matched with any parallel activities throughout Europe. An important task of the EU Commission would be to carefully facilitate the transferability of systemic instruments, developed in heterogeneous national, regional or sectoral contexts, across Europe, thereby providing a *forum* to debate the degree of immediate imitation versus the need of "domestication" (Silverstone & Haddon, 1996); e.g. – as a thought experiment – consider the degree of transferability vs. requested domestication of the German "Futur Process" for innovation-oriented research funding priority-setting (see section 5, above). Such debates would have to be grounded on the results of related policy evaluations as well as other sources of Strategic Intelligence (Kuhlmann et al., 1999).

(2) A key issue of a new, systemic governance of innovation policy is the involvement of a *"new breed" of innovation policymakers*, employed under the rules of a more flexible staff policy (e.g. supporting job rotation with industry or non-governmental organisations), working in an reformed, systemically inter-linked institutional setting, fostering experimentation and learning. One important precondition is a reformed education and training system for policymakers, including lessons on the conditions, means, impacts and pitfalls of systemic policymaking. The EU Commission could facilitate the formation of a new generation of systemically oriented policymakers, not at least by supporting and making use of an infrastructure of Distributed Strategic Intelligence (as e.g. suggested by Kuhlmann et al 1999).

Research question 4: Agenda for further (action-) research

From the analysis presented in the foregoing it becomes clear that, although there are some early experiences with systemic instruments, there still are a lot of open questions. In our view the most important ones include:

1. Further *inventarisation of systemic instruments and comparative analysis* of these instruments focusing on the functions they aim to fulfill and the situations in which they are applied.

2. *In depth analysis* of a limited number of systemic instruments. Major issues that should be addressed in the analysis[40]:
   . contribution to the 5 functions
   . realisation of intended (and unintended) impact
   . impact on other instruments in the portfolio
   . how to organise effective evaluation
   . how to stimulate a *structural* impact
   . how to facilitate learning
   . how to implement creative destruction
   . how to initiate the development and application of new systemic instruments
   . transferability and best practices: examples, conditions, expected results

3. In order to improve the insight into the use of systemic instruments a number of *'Begleitforschung'-projects* of major innovation projects with a strong systemic character, could be initiated. These projects could serve three different goals:
   . provide innovation researchers with insights into the role of systemic instruments in complex and long lasting innovation processes;
   . provide actors involved in the innovation processes with concepts, information and instruments that might help them to realize their goals;
   . the projects could act as a kind of monitoring device and provide insights into the way how these projects can be best monitored and evaluated.

4. The results of the projects proposed in point 1-3 could be used as the input for the development of a *learning database of systemic instruments*. In this database the systemic instruments are classified in terms of functions and situations in which these functions provide an added value. Furthermore the database contains information on experiences with the application of the instruments. The database is a learning one in this sense that it is improved and updated at a regular basis using experiences and results of developers and users of this type of instruments (see also point 6).

5. When discussing the possibilities of transferability of instruments and experiences in the foregoing, it was stressed that this is not easy because of the specificity of the systems in which these instruments are applied. At the same time it was argued that it however, under circumstances, is possible to learn from experiences in other settings. It was also argued that, in order to exploit this 'learning potential', an infrastructure to support these learning processes should be reinforced or even created. More precisely two *network infrastructures* are proposed. The first one focuses on content. The network links relevant sources of information on innovation processes into a structured whole. Major goal of the network is to make it easier for actors involved in innovation processes to trace already existing information that can be of use to them and make this information easily accessible. In developing such a network we can build further on the work of the Advanced Science and Technology Planning Network (Kuhlmann et al, 1999) in which a proposal for a so called infrastructure for distributed strategic intelligence is developed. In annex 2 a summary of this proposal is presented. The second network focuses on the process part. Central element of the network is a so called Policy Laboratory. This PL can be conceived as a learning platform and clearing house facility for the development and use of systemic instruments. The PL is the spider in a network of groups who use these types of instruments and are willing to exchange information on their experiences. Also with regard to this network we need not to start from scratch. In the Netherlands preliminary versions of a Policy Laboratory already function for some years (Smits & Geurts, 1997, Glasbergen & Smits, 2002). In annex 3 some information on one of these PL's is presented.
   It should be stressed again that both networks are dynamic, learning networks that function on different levels and are accessible for various types of actors. Furthermore it should of course be examined carefully in how far these new infrastructures can be linked up with the concept of Networks of Excellence as proposed in the European Research Area.
   An additional advantage of these two networks is that they will make it more easy to carry out the already mentioned studies in which deliberate attempts are made to collect analyses and experiences

[40] Although this report already has a Dutch bias, the Dutch ICES-KIS (interdepartmental committee on economic structure, more in particular on the knowledge infrastructure) would be a good candidate for an in depth analysis. This program aims at a structural reinforcement of the relation between the knowledge infrastructure and users. The program now is in the preparatory stage of the third round of 4 year. This round some 800 million Euro will be invested . The already mentioned, multidisciplinary NIDO is an example of an ICES-KIS project from round 2. In the third round systems innovation is one of the seven 'knowledge themes'. The majority of the projects focus on hard science and technology.

from different innovation systems and integrate them into a comparative, supra-national whole (bench-marking, supra-national foresight).

6. Development of curricula at bachelor and master level in which the management of systems innovation and the use of systemic instruments is put central. Within the framework of the so called Research Program on Transitions towards a Sustainable Development (a proposal for a third round ICES-KIS project) first ideas for such curricula were developed (see appendix 3).

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Appendix 1: Development of Technology Assessment from watchdog to tracker dog[41]

A conventional TA concept versus a new TA concept

The changes in technology policy and technological strategies mentioned above had an impact on the concept of technology assessment. The term 'TA concept' refers to a more or less shared view on the types of activities TA encompasses and the contribution it can make to decision making on technological development. We will briefly describe the changes in the TA concept.
Traditionally, technology assessment is concerned with the potential negative or unwelcome social and economic outcome of technological development. From this perspective technology assessment has been (and in some cases is still seen as) an activity taking place outside the process of formulating technology policy and technological strategies. Its major functions were 'early warning', evaluation, and a type of 'counter-intelligence'. This traditional concept of TA started to lose ground in de mid-70s and the change was described in several reports (see for instance Boroush et al., 1980; Smits en Leyten, 1988; Paschen et al., 1989)[42]. See also box 1.

Box 1: The old' versus the 'new' Technology Assessment concept.

The 'old' TA concept (Coates, V.T. (1975) 'Readings in technology Assessment', George Washington University, Washington)

Technology assessment is the systematic identification and evaluation of the potential secondary consequences (whether beneficial or detrimental) of technology in terms of its impact on social, cultural, political, economic and environmental systems and processes.
Technology Assessment is intended to provide a neutral, factual input into the decision-making process.

The 'new' concept (Smits, R. & A. Leyten 'Technology assessment and technology policy in Europe: new concepts, new goals, new infrastructures', in: *Policy Sciences* (28))

Technology Assessment is an analysis process of technological developments, their consequences, and the discussions about them. The aim of Technology Assessment is to provide information that will help the parties involved to determine their strategy and enable them to define new objects for Technology Assessment research.

In the new concept, which emerged in the late 1970s, scientific analysis of technological developments and their impacts had to take a step backwards in a number of ways. Expectations of the potentials of scientific TA research are considerably less highly pitched. The all-embracing TA of the early years has been replaced by consecutive partial studies in which knowledge gained in one is passed on to the next. Moreover, TA has extended the participation of actors from outside the scientific community. They are no longer involved only at the outset, when deciding on the subject for study, and upon completion, when the results are ready. Much attention is now given to starting a dialogue between both the researchers and users of TA. Policy makers and other potential users are often intensively involved in the formulation of the problems, frequently participate as suppliers of information, and are involved in determining how the research process is organised. This stronger linking of TA to the decision-making process has led to increasing the popularity of the concept of TA as a multiform research capacity with sufficient opportunities for discussion and contradictory views and findings. In the table below the old and new concepts are contrasted by using key words.

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41 Taken from Smits, R., A. Leyten & P. den Hertog, 1995.

42 See: Boroush, M., K. Chen and A. Christakis (1980). Technology Assessment: Creative Futures: Perspectives from and beyond the Second International Congress. New York: Elsevier North Holland.
Paschen, H., T. Petermann, J. Schevitz and R. Smits (1989). 'Review of TA institutionalisation on selected OECD countries' a paper presented at the OECD conference on technology assessment, Vienna (June).
Smits, R. & A. Leyten (1988) 'Key issues in the institutionalisation of technology assessment', in: *Futures*, February.

The conventional versus the new TA concept

Conventional TA concept	*New TA concept*
Science's dominant role	**Equal role for researchers and users**
High expectations of the research potential	*Modest expectations of TA research*
TA output: study report	*TA output: study and discussion*
Little attention for problem definition	*Much attention for problem definition*
A single TA research organisation	**Multiform TA research capacity**
Instrumental use of TA information	*Conceptual use of TA information*
TA results incorporated in the decision-making process	*'Tuning' of TA and decision making*
Autonomous technology	*Technology as human creation*

With regard to the type of activities it involves, the new TA concept is much more interactive than the old one. TA now has to be seen as a process of studies and discussions which runs parallel to – and has close links with – decision making processes. Its main goal is to support the different actors involved in development, production, supply and usage of new technologies in formulating their strategy with regard to the new technologies. In this sense it is much more of an advisory type of activity than a scientific research activity.

The development of a comprehensive technology policy[43]

The new TA concept described above makes it easier for us to establish a better link between technology policy and TA and to introduce the notion of comprehensive technology policy. The basic assumption of this more 'user-oriented' technology policy is that it is necessary to close the gap between socio-institutional and techno-economic developments and strategies. The general framework for developing such a comprehensive technology policy can be seen as the following revolving process:

1. Certain existing socio-institutional and economic conditions and goals are the basis for formulating strategies with regard to the development and implementation of new technologies.
2. The technological strategies will lead to certain (expected) impacts on the socio-institutional and economic environment, largely based on how users and other parties concerned interact with the new technologies.
3. The potential or expected impacts of technological strategies may lead to changes in the socio-institutional and economic conditions for implementing the technological strategies, or to changes in the technological strategies itself.

The societies in which we live dispose of two basically different mechanisms to regulate this process and make choices more or less explicit. The first is the logic of the market mechanism and profit maximisation. The second is the set of active policies of governmental bodies and common agreements. In both regulatory mechanisms, the described process revolving around expected outcomes must be reinforced to fulfil the need for a comprehensive technology policy.
Technology Assessment can contribute to this aim:

- By generating knowledge and stimulating awareness about social, economic and material possibilities of choice in relation to technological developments, in which special attention must be given to the position and interests of users to improve the process of demand articulation;
- By stimulating the debate on the direction of technological developments in relation to socio-institutional questions (to maximise the profits, a particular society (national, regional) with given characteristics and potentials can reap the rewards from technological developments);
- By supporting the development of technological as well as socio-institutional innovative strategies, which guide the process of finding useful and desirable applications.

In this sense, Technology Assessment can contribute to the 'tuning' of techno-economic and socio-institutional subsystems, which is especially important in societies and user communities that have no substantial influence on the supply of new technologies, as in the greater part of Europe. We consider TA to be an institutional 'change agent' which at a strategic level continuously tries to bridge the gap between the two subsystems. TA

43 The concept of 'comprehensive technology policy' is to a certain degree interchangeable with concepts used today such as integral-oriented, user-oriented or demand-oriented innovation policy.

can be useful in making choices more visible or more explicit in an early stage of technological developments and by stimulating interaction between those supplying and those using technologies for specific needs.
With regard to its role in decision making on technological developments the traditional reactive early warning TA concept had much in common with a 'watch dog', whereas in the new concept TA looks more like a 'tracker dog'.
TA in the new concept is pro-active. It plays an active role in the development of technologies and their applications. In our view, this tracker dog concept is not only more realistic, but at the same time is more generic to the process of developing a comprehensive technology policy.
With this change, the relation between TA and technology policy also changes. By no longer emphasizing the negative consequences of technology, TA probably loses its often perceived threatening and negative image vis-à-vis the exponents of technological development (i.e. R&D) institutions and R&D-intensive companies). This could possibly eliminate an important obstacle for the integration of TA as a part of technology policy. A comprehensive technology policy presupposes the importance of the social embedding or broadening of decision making on future technological scenarios. The purpose is not only to democratise the way choices in technology policy are made and how technologies are used to fulfil societal needs, but also to improve the (future) competitiveness of industry.

Appendix 2: Outline of a Distributed Strategic Intelligence Infrastructure[44]

...To sum up briefly, in this paper we have argued for a new approach which we have called a system of distributed intelligence. In particular we have suggested the development of tools that can be used in different combinations to enhance strategic intelligence inputs into policy-making and access to, and exploitation of, strategic intelligence at different locations for different reasons. Initiating and exploiting these intelligence tools in a systematic fashion across innovation systems will demand new architectures, institutions, configurations and their inter-linkages.

This paper started by quoting Friedrich Nietzsche: "Before any impact you believe in other causes than after the impact". If we manage to develop and implement a new strategic intelligence infrastructure, the research and innovation policies could become more realistic, efficient, more relevant, and more democratic. Four *basic principles for effective strategic intelligence* were figured out in this paper:

1. *The principle of participation:* Foresight, evaluation or technology assessment exercises ensure the diversity of perspectives of actors by preventing them from maintaining one unequivocal 'truth' about a given innovation policy theme.
2. *The principle of 'objectification':* strategic intelligence facilitates a more 'objective' formulation of diverging perceptions by offering appropriate indicators, analyses and information processing mechanisms.
3. *The principle of mediation and alignment:* strategic intelligence facilitates mutual learning about the perspectives of competing actors, and their mutual interests can simplify alignment of their views.
4. *The principle of decision support:* the outcome of strategic intelligence processes will facilitate political decisions and effectuate the subsequent successful implementation.

There is consequently no single 'correct' or 'best' configuration of tools, procedures, institutions and structures that can be used in all contexts and situations. So far, the focus has been on national level policy configurations, but we can see that regions and supranational organisations, or even 'thematic' organisations, become more important as policy arenas. Moreover there is a growing need for new configurations to establish a link between private and public actors and promote their interaction. By 'private actors' we not only mean companies, but also the representatives of numerous stakeholders (professional associations, consumer organisations, environmental organisations, etc.).

The application of strategic intelligence can be further effectuated if information is gathered simultaneously from several independent and heterogeneous sources. Therefore a *second route* to improved strategic intelligence leads us to the concept of *distributed intelligence.* This concept starts from the observation that policy makers and other actors involved in innovation processes only use or have access 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.

In distributed intelligence, a decentralised architecture of information sources will be unfold – spanning across innovation systems and related policy arenas – working as brokering nodes which guide and enable the supply of strategic intelligence. Five *general requirements* of such infrastructures can be stipulated:

1. *Network requirement:* distributed intelligence will not be designed as a top-down system – rather the opposite: ideally the design allows for multiple vertical and horizontal links across the existing sources of strategic intelligence.
2. *Active node requirement:* three types of active nodes can be distinguished: (a) The first type provides enabling facilities, e.g. a 'foresight bank'. (b) The second type delivers a 'directory' allowing direct connections between relevant actors. (c) A third type offers a 'register' allowing free access to all strategic intelligence exercises undertaken under public auspices, hence facilitating collective learning processes.
3. *Transparent access requirement:* clear rules concerning the access to the infrastructure of distributed intelligence are needed.
4. *Public support requirement:* distributed intelligence infrastructure is in need of a regular and reliable support by public funding sources.

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[44] Taken from Kuhlmann (2001c)

5. *Quality assurance requirement:* three major avenues of quality assurance can be followed: (a) professional associations; expert journals; university teaching; (b) accreditation mechanisms for providers of strategic intelligence, based on a self-organising 'scene' of experts; (c) a reliable support with repeated and 'fresh' strategic intelligence exercises and new combinations of actors, levels and methods initiated by innovation policy makers across arenas and innovation systems.

Appendix *3 : The Policy Laboratory*[45]

The development and use of a Policy Laboratory

The management of transition processes is confronted with what is often an internally contradictory knowledge housekeeping which is disseminated and stored throughout an enormously widespread area. The relevant expertise is from numerous, widely differing disciplines, both scientific and otherwise. An additional factor is that our society is also becoming progressively more complex, and the context within which decisions have to be made is rapidly changing. Decision-making processes are more intensive, involve more levels at the same time, and there is also an increase in the number of actors involved. Another factor that plays a role here is that the differences in perception and information make communication between the actors more difficult. Policy makers often have insufficient knowledge, expertise and experience at their disposal to be able to act ahead of these processes of transition. Management of the (many) interfaces among researchers, policy makers and other stakeholders frequently give rise to numerous problems in this respect. In that case there is an enormous need for knowledge and instruments that make it possible for policy makers to mould their contribution towards managing transitions in interaction with researchers and other players. It is our intention to use the study programme as a contribution towards reinforcing these interactions and thus to contribute towards a maximum use of the knowledge potential of all stakeholders – i.e. including the policy makers themselves – and to ensure that the results of the study are passed on to the users of that policy, and others, as quickly and as effectively as possible. This involves in particular:

1. the transfer of both formal and informal (tacit) knowledge;
2. verification of the actual results of the study programme;
3. encouraging the forming of opinions, articulating the question and the actual setting of agendas;
4. contributing towards alignment and consensus forming by means of debate and a confrontation of points of view;
5. adopting the role of a learning and experimentation platform.

The programme wishes to contribute to this through the (further) development and introduction of a Policy Laboratory (PL). In brief, this PL is a location where the knowledge, expertise, people and instruments required for the purpose of adequately supporting actors involved in the management of transition processes are gathered together[46]. The PL has a Janus face in the sense that on the one hand the concern is to transfer knowledge and use instruments, and on the other hand to develop that knowledge and instruments further (see the box below).

POLICY LABORATORY
(taken from: Bongers, Wieringa, Smits, Glasbergen (2001) 'Het beleidslaboratorium aan de Universiteit Utrecht' [The policy laboratory at Utrecht University], Utrecht University, Faculty of Geographical Sciences.)

... Numerous initiatives are taken in the Netherlands every day for the purpose of involving citizens, experts and non-governmental organisations in the policy-making process and its subsequent implementation. This can be in the form of more traditional methods such as district discussion panels, debating forums, public enquiries or hearings. To an increasing extent this entails more cohesive methods for the involvement of stakeholders in which the interactive media are now starting to play a more intensive role. Several of these tools and methods are focused on in the PL. For instance: electronic meeting systems, referred to in the literature as Group Support Systems or Groupware Play Simulation (role playing with or without modelling data), digital or Internet debates, scenario workshops, civic debates and citizen panels, focus groups, local policy conferences or consensus conferences... .

The PL supports actors involved in transition processes at both the relevant and the process level. In this context, *relevant* refers to the nature of the strategic information required by the actors involved in the transition processes to enable them to achieve their goals. An understanding of all new developments of relevance to our economy, how these developments are appreciated by the different parties, the consequences associated with the

45 Taken from J. Rotmans, J. Schot & R. Smits (2002)

46 Smits, R. & J. Geurts (1997) 'Het Beleidslaboratorium', TNO-Apeldoorn/Tilburg University.

realisation of these developments, and an insight into the influencing options available to those involved is given a great deal of attention. In addition to the implementation and transfer of specific studies, the organisation of a knowledge system built up of (already existing) sources of knowledge and intermediary organisations that attempt to establish the link between the supply and demand of knowledge is also of main concern here.

Process in this respect refers to the consequences of managing transitions, and therefore also the associated system innovations for the set of instruments used by policy makers and other persons involved in processes of innovation, thus enabling them to realise their objectives. This sort of management sets high demands on the actual managing of the interface between the organisations and the systems within which they operate, on the forming of strategic alliances, the ability to mobilise the creative potential of the actors involved, on the flexibility of institutions and systems and on institutional arrangements facilitated by horizontal policy and teamwork. One major component of this set of instruments consists of tools that help to eliminate a number of the barriers among the actors in the systems[47]. New trends have been underway in this area over the past few decades. Strategic workshops, scenario workshops, electronic meeting systems, gaming and consensus development conferences are but a few of the many examples that can be mentioned here.

The PL was built on our recent experiences with group decision support systems, scenario workshops en gaming[48], linked to studies already underway at the Copernicus Institute for Sustainable Development and Innovation of Utrecht University where advanced plans are already in place for developing a PL and to the plans at TNO-STB (TNO Strategy, Technology and Policy) for developing a Centre for Interactive Policy Development (CIPD). This specifically concerns:

1. The further development of the PL as a concept. This involved issues such as: which instrument results in what kind of outcome, in which stage of the transition process and in what setting? Output: a manual for process architecture and a library of instruments.
2. The development and testing of relevant and procedural instruments that can be put to use in the PL in order to give support to the actors involved in the process of transition. Output: specifically customised transition programmes geared towards 'interactive' instruments.
3. The organisation of constant interactions between researchers, policy makers and crucial stakeholders in which questions and issues concerning the actual steering of transitions and system innovations have a central role. Examples of questions dealt with in this respect are:
   - Which actors should we involve and which should we not involve in the transition process?
   - Should the government take the initiative for transition experiments?
   - Should there first be a thorough desk study carried out into the actors before the acto selection process?
   - On the basis of what criteria should the actors be selected? (existing network, authority, influence, turnover, known by the public)
   - How can the different stages of a transition be identified and monitored? This can be most difficult, especially in the pre-development stage.
   - What sort of skills for transition management are required of public servants?
   - How do we structure the transition process and under what conditions? Is it obligatory or non-committal? Must everyone be in agreement?
   - How do you prevent actors from dropping out in such a long-term transition process?
   - How do we initiate discussions with actors, and when?
4. The organisation of interactions with the more general public by means of interactive Internet sites and the organisation of public debates as was recently done by the Rathenau Institute and other organisations on issues concerning the 'social aspects of the new biotechnology'.

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47 In his speech entitled 'Omkijken naar de toekomst'[*A look back at the future*] (Tilburg University, 1993) Geurts spoke of four gaps in this respect, namely the gaps between:
- practical policy processes and science;
- the various (scientific) disciplines;
- the managers and those managed;
- experts and laymen, and between the producers and the users of knowledge.

48 See Bongers, F. (2000) 'Participatory policy analysis and group support systems', dissertation Tilburg University, and Mayer, I. (1997) 'Participatory policy analysis: debating technologies', dissertation Tilburg University.

Training

The management of transition projects and system innovations calls for specific knowledge, experience and skills. Currently, the traditional educational circuit is meeting this need in very small quantities only. There is only a very limited number of programmes offered at both higher professional education and university levels of education that contribute towards deepening the insight into transition processes and system innovations. Nor is much attention given to the management of transition processes and the implementation of those instruments developed (and will be developed) specifically for this purpose. In order to help fill this gap, the programme – in close interaction with the educational field – wishes to contribute towards:

1. Master's degree programmes in science subjects and the social sciences at both higher professional education and university levels of education in which the deepening of insight into transition projects and system innovations in the generic sense come first and foremost. Subjects such as system theory, ecology, innovation theory, management theory and policy studies and public administration could form a part of these Master's programmes in which the emphasis would be on research.

2. Bachelor programmes at both higher professional education and university levels of education that contain a specific, central transition programme. Examples can be found in the energy sector, agriculture and the knowledge community. In addition to the dynamism of the specific transition and knowledge of the fields concerned, training in the management of these programmes forms an essential part of the study programme. Instruments from the Policy Laboratory could be used for these courses, for instance to provide the students with an understanding of the dynamics of complex systems or to acquaint them with strategy development via scenario workshops.

3. Courses focusing on specific transition programmes, geared towards those actors active in the relevant programme.

As already stated, these study programmes and courses will be developed in close interaction with the educational field. The problem is, however, that particularly in university education, multi-disciplinary education, and certainly in the research that must be fed by this field of education, is scarcely out of the egg. Developers of this kind of study programmes are unable to restrict themselves to developing the curriculum only, but will also need to initiate the discussion that leads to a U-turn in the cultural sense. In the academic community there are several study programmes to which links can be established even now. We will suffice here by mentioning the Eindhoven University of Technology's Technology and Society study programme and Delft University of Technology's Systems Engineering, Policy an Analysis programme, the programmes Environmental Sciences and the Natural Sciences, and Innovation Management of Utrecht University. In all of these science subjects and social science study programmes use is already being made of Policy Laboratory instruments, particularly group decision support systems. These programmes are all based on a system perspective, the theme of sustainable development plays a major role, and all currently find themselves – as do all study programmes – in the transitional stage to the new Bachelor Master System. The latter would seem to offer first-rate opportunities to jointly set up new study programmes.

Appendix 4: Transition processes in the greenhouse sector[49]

A contribution to current transition programmes

This part of the programme concerns supporting several (experimental and current) transition programmes in practice. It is the intention that the members of a transition team (see below) support the implementation of these transition experiments. The actual implementation will taken place by networks of societal actors who in turn will be given analytical and process support from a group of transition researchers and transition experts. An example of such a transition experiment could be the transition to 'climate-neutral horticulture under glass'. The aim is to achieve a vital, sustainable and respected horticulture under glass sector in the Netherlands. The ambition is to use, exclusively, a sustainable energy system in new horticultural clusters in the year 2015; a system that has been proven to be feasible in the technological, the economic and the societal sense. Widely-based support must also be obtained for such a transition, as well as for the kinds of experiments associated with that support by the horticulture under glass community. Around 2010-2015 all *newly established* horticultural clusters must use a sustainable system. In this, and in the coming period, already existing horticultural complexes are to be transformed into sustainable energy systems. The entire transition can take some 30 years to complete: a too rapid and too drastic transformation would cause far too much destruction of capital.
This transition process in the horticulture under glass sector will not start from scratch, it can more be likened to a train which is already in motion. Current policy has already been set out in this direction in the long-term agreement entered into with the horticulture under glass sector on the subject of energy. And yet there is still the need for support in terms of research for the set up and implementation of this horticulture under glass transition experiment. This support covers three parallel tracks as one of the components of a cyclic process of transition:

(i) *an analytical track*: in which the transition to a climate-neutral horticulture under glass sector is analysed in terms of strengths, weaknesses, opportunities and risks, and in which the ultimate models and management options are explored and knowledge questions identified.

(ii) *a process track*: in which interactions and teamwork with both directly and indirectly involved societal actors take place, varying from bilateral discussions to larger workshops. Potential actors could be: LTO (Dutch Organization for Agricuture and Horticulture), public utilities, the Dutch Horticultural Council, suppliers, greenhouse project developers, insurance companies, financiers and environmentalist movements.

(iii) *an experiments track*: in which experiments and pilot projects for a climate-neutral horticulture under glass sector is given support. These experiments provide insight as to how far the transition goals have been accomplished, and which of the experiments are or are not feasible. Examples of such transition experiments are the use of hydrogen technology as the source of energy and pilot agro-production parks.

The three tracks come together at fixed times where they assist and support one another: the one track makes good use of the insights and experiences of the other tracks. The proposed *interim transition targets*, the *transition process* and the *undertaken transition experiments* are evaluated in development rounds. If targets are not met, the reason why is looked into, for instance by unanticipated societal developments and external factors such as amendments in European legislation and regulations in the field of horticulture under glass, the increasing importance of certification, and a stronger growth in international competition. The process itself is also scrutinised, in which use is made of an adaptive management paradigm, making use of learning stages, experiences, new knowledge and new circumstances, possibly resulting in new points of departure and new choices. This 'learning as you go along' and 'working while learning', in which strategic niche management is crucial: specific experimentation with technological, economic, socio-cultural and institutional options that seem highly probable. Not only the experimenting itself, but also having the courage to learn and protect experiments from too premature large-scale application is one of the components of niche management.
The above transition experiment will in the first instance take some ten to fifteen years to complete, and one of the important objectives is to see that the transition towards a climate-neutral horticulture under glass sector really gets off the ground and bring it into the take-off stage.

Other examples that can then be set up and implemented in a similar fashion is a transition to the clean fossil and hydrogen economy in the form, of a transition experiment in the field of energy. A link could also be established here with the policy currently under development by the Ministry of Economic Affairs to achieve a sustainable

[49] Taken from J. Rotmans, J. Schot & R. Smits (2002).

energy supply. The Innovation Science Discipline Group of Utrecht University has already carried out a great deal of work in this field; work that can certainly be progressed upon with success.