Improving Distributed Intelligence in Complex Innovation Systems

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Executive Summary

It is the year 2005 and the Managing Director of Biomat has a problem. Her spin-off firm builds replacement human organs using metagenic technology, but after two years of success Biomat is at a crossroads. Should it stick to metagenics, which is costly and prone to production problems, or should it use the latest ultragenic approaches - still unproven but likely to yield great cost reductions?

She switched on her videophone and traced the local head of RIB, the Regional Innovation Bureau of ENDBITS, the European Network of Distributed Bureaux of Intelligence for Technology Strategies. RIB helped her to prepare a videonote on technology options. It ran a standard search on the European Foresight Bank, an electronic tool which logged all of the world's foresight outputs and used AI algorithms to cluster the results and build scenarios. Recent expert assessments all looked good for ultragenics, but RIB advised her not to rely solely upon foresight results – however positive. Social and regulatory problems were also possible, and the Bureau had heard of some problems in Austria.

RIB used the Technology Assessment directory to identify the main Austrian experts in the field and confirmed that ultragenics had been subject to ethical challenges from a local religious foundation. RIB then called for more information and scanned the recordings of the Consensus Conference. Relief! The objections were based on a misunderstanding of the procedures for ultragenics (which unlike earlier approaches did not depend upon foetal cells) and the citizens' jury had come out in favour of the technology.

Biomat was ready to launch its ultragenics research programme, but was worried about the cost. RIB pointed out that all three of the European Research Framework Programme agencies offered support, but noted that recent evaluations praised the Prague office for its fast turnaround of proposals and claims.

"Thanks RIB" said the Biomat MD. "Life without ENDBITS just wouldn't be the same."

The basic premise of this report is that more and better access to relevant information makes for better decision-making and sounder decisions. Whether located in the public or private sector, decision-makers concerned with technology choices, strategies and policies need a wide range of high quality intelligence inputs in order to make wise decisions.

Traditionally, policymakers and strategists dealing with technology and innovation have used a number of "intelligence" tools and techniques to provide them with the data they need to formulate appropriate policies and strategies. In the public sector, for example, innovation policy formulation has been improved in recent years via the use of Technology Foresight, Technology Assessment and Policy Evaluation exercises. All have yielded valuable information which has helped policymakers make wise technology choices and fine-tune courses of action.

In future, however, more will be needed. The complexity of the modern world and the crucial role innovation plays within modern economies and social structures make it imperative that intelligence tools are improved and access to the results of intelligence exercises carried out across the globe is enhanced.

In this report we review the use of a number of intelligence tools in innovation policymaking before going on to examine how they could be used in different combinations to enhance strategic intelligence inputs into policymaking. Critically, we also examine the need for a system of "Distributed Intelligence" which could provide policymakers with access to strategic intelligence outputs produced in different locations for different reasons. Specifically, we use a number of stylised "fictions" such as the Biomat example to explore the design requirements of a "system architecture" for distributed intelligence.

In the concluding section we consider innovation policymaking in Europe and contemplate some of the steps needed to improve the use of intelligence tools and to build an effective European system of distributed intelligence. The aim is not to specify in detail the shape of a monolithic ENDBITS, but to suggest just a few of the ways in which Europe could improve innovation policymaking and, ultimately, innovation policy.

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1. Introduction: Improved Strategic Intelligence for Policy Formulation in Complex Innovation Systems

Preamble

HAMLET.
... Thus conscience does make cowards of us all,
And thus the native hue of resolution
Is sicklied o'er with the pale cast of thought,
And enterprises of great pitch and moment
With this regard their currents turn awry
And lose the name of action ...

William Shakespeare, Hamlet, Act III, Scene 1

Hamlet's concern may well apply to this report. The authors' academic "conscience" may have made "cowards" of them, and "the pale cast of their thought" may have obstructed an "enterprise of great pitch and moment". The authors, nevertheless, are confident that the open-minded reader will recognize that there is some "name of action" inherent to the ideas put forward by this report.

The report has been produced by members of the *Advanced Science and Technology Policy Planning Network*[1] – a network set up as part of the Targeted Socio-Economic Research Programme of the European Union. Details of the network, its task and workshops conducted can be found in Appendix 1.

The aim of the report is to explore and suggest ways in which innovation policy and innovation policymaking can be improved. Innovation policy is here defined as the entire scope of related public measures of science, research, technology policy, overlapping also with industrial, environmental, labour and social policies.

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The policy challenge confronting society is to evolve policies capable of effectively nurturing innovation within modern economies and social structures – a task made intrinsically difficult by the complexity of innovation systems and their dynamics.

One way of enhancing policymaking is to improve the *Strategic Intelligence (SI)* upon which policy choices and decisions are based. In the past this intelligence was generated via tools such as *Evaluation (EV), Technology Foresight (TF)* and *Technology Assessment (TA)*. Improving the way these tools are used is one way of improving strategic intelligence and hence policymaking.

In this report we argue that there is now a need to go further. In particular, we suggest two key developments, namely

- the development of *Enhanced Tools (ET),* i.e. SI tools which can be used in different combinations to enhance strategic intelligence inputs into policymaking
- the exploitation of *Distributed Intelligence (DI),* i.e. access to, and exploitation of, SI produced in different locations for different reasons

Furthermore, in order to produce *Improved Strategic Intelligence***,** there is a need to develop the institutional infrastructures which will allow both the use of enhanced tool combinations and facilitate the combination of multiple intelligence inputs from an accessible distributed intelligence architecture.

In developing our ideas about Distributed and Improved Strategic Intelligence we might have "overshot the mark" – if the horizon is defined by innovation policy-planning and -making concepts still normally in use. Also, one might accuse us of presenting ideas of a far too theoretical and generalistic nature, not immediately applicable to the real world of innovation policymaking. Well, such critics may be right, though it is only broad-minded thinking that helps to overcome the "path dependencies" of conventional taken-for-granted practices. Moreover, we shall present a couple of examples providing at least some empirical evidence of the emergence of Distributed and Improved Strategic Intelligence.

In the remainder of this report we develop these ideas. Chapter 2 considers the development and use of strategic intelligence tools such as EV, TF and TA. It explores ways of improving these individual tools and ways in which they can be used in combination to produce more useful strategic intelligence. Chapter 3 goes on to describe the main elements of distributed intelligence and argues why there is an increasing need for policymakers to access multiple intelligence sources when formulating effective innovation policies. This will be illustrated by four "fictions", i.e. short stories of future uses of "Improved Strategic Intelligence": (1) an SME considering a strategic technological move; (2) a region considering its new "education, research and innovation" contracts with the nation and the EU; (3) developing a new EU technology programme; (4) facing a new collective risk - the Ebola virus. In chapter 4, conclusions are drawn and suggestions made regarding the development of an infrastructure capable of supporting new tool combinations and access to distributed intelligence.

1.1 Complex Innovation Systems and the Need for Improved Strategic Intelligence

Science, technology and innovation have long been recognised as important drivers of economic development. Indeed, some would argue that they now occupy a position of critical centrality in modern economic and social structures. As such, policymakers have become increasingly interested in the development of policies to ensure that science, technology and innovation continue to underpin economic development.

Other factors have also fuelled an interest in innovation policies. Science and technology are neither costless nor necessarily benign activities, and society has a right to become involved in determining the level of resources devoted to them. Society also has a role to play in shaping and determining the directions in which scientific developments are allowed to evolve. The need for societal choice and control thus implies the need for science, technology and innovation policies.

Specifying these policies is not easy, however. Analysts in the field have abandoned simplistic models of how innovation and innovation processes work. It is increasingly recognised that the dynamics of so-called "innovation systems"[2] are complex and difficult to understand, and that scientific and technological communities, not to mention the "users" of their products, face a number of challenges, both now and in the future[3]:

(1) *The nature of technological innovation processes is changing*. The production of highly sophisticated products makes increased demands on the science base, necessitating inter- and trans-disciplinary research and the fusion of heterogeneous technological trajectories.[4] New patterns of communication and interaction are emerging which researchers, innovators and policymakers have to recognise and comprehend;

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2 Or (national) "systems of innovation"; see Freeman, C. (1987): Technology Policy and Economic Performance: Lessons from Japan, London (Pinter); Lundvall, B.-Å. (1992) (ed.): National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning, London (Pinter); Nelson, R. R. (ed.) (1993): National Innovation Systems: A Comparative Analysis, Oxford/New York (Oxford University Press); Edquist, Ch. (1997) (ed.): Systems of Innovation. Technologies, Institutions and Organizations, London/Washington (Pinter).

3 See also Lundvall, B.-Å. / Borrás, S. (1998): The globalising learning economy: Implications for innovation policy, Luxembourg (Office for Official Publications of the European Communities) (Targeted Socio-Economic Research).

4 See e.g. Grupp, H. (ed.) (1992): Dynamics of Science-Based Innovation, Berlin et a. (Springer); Kodama, F. (1995): Emerging Patterns of Innovation. Sources of Japan's Technological Edge, Boston (Harvard Business School Press).

(2) *The "soft side of innovation"*[5] *is also of growing importance*. Non-technical factors such as design, human resource management, business re-engineering, consumer behaviour and "man-machine interaction" are critical to the success of innovation-processes. As a consequence, the learning ability of all actors in the innovation process is challenged and it becomes more appropriate to speak about a "learning economy" than a "knowledge-based economy"[6].

(3) These first two points are specific manifestations of what Gibbons *et al*[7] call the transition from *mode-1 science to mode-2 science*. Mode-1 refers to traditional science-driven modes of knowledge production. Mode-2 refers to knowledge production processes stimulated and influenced far more by demand, in which many actors other than scientists also have important and recognised roles to play.

(4) The pressure on the science and technology (S&T) and the innovation system to function more effectively is complemented by similar pressures to function more efficiently, largely driven by the growing costs of S&T. This will require *a much better understanding of the research system itself*[8]. In this respect, SI (e.g. S&T policy evaluations) can help sharpen insights into the internal dynamics of S&T and their role in innovation systems.

(5) Within more demand-oriented national and regional innovation systems, scientists are under increasing pressure *to produce results* in terms of concrete solutions for societal problems and contributions to the competitiveness of the national economies. This necessitates effective links between the supply and demand sides of knowledge production, which in turn *increases the demand for Strategic Intelligence*.

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

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5 See e.g. Den Hertog, P. / Bilderbeek, R. / Maltha, S. (1997): Intangibles. The soft side of innovation. In: Futures, Vol. 29, No.1, 33-45.

6 This is recommended "since the high pace of change means that specialised knowledge becomes much more of a short-lived resource and that it is rather the capability to learn and adapt to new conditions that increasingly determines the performance of individuals, firms, regions and countries" (Lundvall/Borrás 1998, 31).

7 Michael Gibbons et al. (1994) The new production of knowledge: the dynamics of science and research in contemporary societies. London: Sage Publications.

8 See e.g. Rip, A. / van der Meulen, B. (1997): The post modern research system, in: Barré, R. / Gibbons, M. / Maddox, J. / Martin, B. / Papon, P. (eds.): Science in Tomorrow's Europe, Paris (Economica International), 51-67.

(7) The growing cost of S&T is also likely to accelerate the *increasing international division of labour in the European S&T system*, a development which will increase both the pressure and the need for a highly strategic, though not necessarily a centralised, European S&T policy.

(8) Since the 1980s, the *adaptability of the innovation systems* to changing markets has been perceived with increasing clarity as a critical factor in the international competitiveness of the participating economic actors[9]. In the transition to the 21st century the national (and regional) innovation systems are experiencing revolutionary shockwaves: the increasing pull of "globalising" economic relationships has mixed up ingrained regional or national divisions of labour between industrial enterprises, educational and research institutions, as well as administration and politics, and devalued many of their traditional strengths. Up to now, however, globalisation has not led to conformity of the national innovation systems, which would result in their abolition. Rather, the various innovation cultures react in quite different ways, which in some cases leads to crises, in others to stability, and in some reveals unsuspected, novel chances in the transformed global context – a challenge to public innovation policies.

(9) Finally, Europe has to overcome the so-called *European Paradox* – the relatively weak ability of Europe to capitalise upon a comparatively strong scientific position in terms of industrial innovation.

Policy-formulation in these circumstances is not straightforward. There is increasing pressure on policymakers to:

- *increase efficiency and effectiveness* in the governance of science and technology;
- *make difficult choices* in the allocation of scarce resources for the funding of science and technology;
- help preside over the establishment of an *international division of labour in science and technology* acceptable to all actors involved;
- integrate "classical" innovation policy initiatives with broader socio-economic targets, such as reducing unemployment, fostering the social inclusion of less favoured societal groups and regions, as claimed in particular by the 5th Framework Programme of the European Commission;
- acknowledge, comprehend and master the *increasing complexity* of innovation systems (more actors, more aspects, more levels etc.);
- adapt to *changes in the focus of innovation policies* between international (growing), national (declining) and regional (growing) levels.

Over the last two decades, considerable efforts have been made to improve inputs into the design of effective science, technology and innovation policies. In particu-

9 See e.g. M.E. Porter (1990): The Competitive Advantage of Nations, London (Macmillan).

lar, formalised methodologies have been introduced and developed which attempt to analyse past behaviour (EV)[10], review technological options for the future (TF)[11], and assess the implications of adopting particular options (TA)[12].

Achievements in these areas have been impressive. As a complement of EV, TF and TA, other intelligence tools such as comparative studies of the national, regional or sectoral "technological competitiveness", benchmarking methodologies etc. were developed and used. Policymakers at regional, national and international levels have all benefited from involvement in these processes and exploited their results in the formulation of new policies. Increasingly, however, it has become obvious to both policymakers and the analysts involved in the development and use of SI tools that there is scope for improvement. In particular, there is a need to improve existing SI tools and use them in more flexible and intelligent ways, combining them in individual exercises to satisfy the multiple needs of innovation policymakers. These are the concepts we try to capture in this report via the use of the term *Enhanced Tools (ET).*

There is a further need, however, to exploit potential SI synergies within what we call a system of *Distributed Intelligence*. Currently policymakers in different parts of the world independently call for localised SI activities to be customised to their own particular needs. In this report, however, we argue that the results of many of these exercises have a didactic value in other contexts. We also argue that the competence, which exists within the SI community as a whole, can also be exploited more broadly by policymakers in localised settings.

If the use of Enhanced *Tools* is combined with the effective exploitation of *Distributed Intelligence*, we believe the result will be *Improved Strategic Intelligence*.

Before considering these issues further in Chapters 2 and 3, however, further discussion is needed of the context within which infrastructural changes will be

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10 See e.g. the survey of various European national systems of evaluation by Georghiou, L. (1995): Research evaluation in European National Science and Technology Systems. In: Research evaluation, Vol. 5, No. 1, 3-10; Papaconstantinou, G. / Polt, W. (1997): Policy Evaluation in Innovation and Technology: An Overview. In: OECD (ed.): Policy Evaluation in Innovation and Technology. Towards Best Practices, Paris (OECD); Callon M. / P. Laredo / Mustar, P. (1997): The Strategic Management of Research and Technology, Paris (Economica International).

11 For various approaches and ways of implementation of technology foresight see Martin, B. (1995): Foresight in Science and Technology. In: Technology Analysis & Strategic Management vol. 7, no. 2, 140; Cameron, H. / Loveridge, D. / Cabrera, J. / Castanier, L. / Presmanes, B. / Vasquez, L. / van der Meulen, B. (1996): Technology Foresight - Perspectives for European and International Co-operation, Manchester (PREST: Mimeo); Grupp, H. (1998) (ed.): Technological Forecasting & Social Change; Special Issue on Recent National Foresight Activities, Vol. 57.

12 See e.g. Rip, A./ Misa, Th.J. / Schot, J. (eds.) (1995): Managing Technology in Society. The Approach of Constructive Technology Assessment, London/New York (Pinter); see also International Journal of Technology Management (1996): Special Publication on Technology Assessment (Guest editor: Denis Loveridge), Vol. 11, Nos 5/6.

needed. In particular, fuller coverage is needed of the complexity of modern-day innovation policymaking in multi-actor/multi-level arenas.

1.2 Innovation Policy in Multi-Actor/Multi-Level Arenas

This section provides a *set of assumptions*, based on our analysis of the *functioning of advanced SI* in complex innovation systems.

First of all, our analysis is based on a *twofold basic assumption*: Innovation policy-making - using SI - is pursued by political-administrative institutions and actors (e.g. ministries for S&T), by research organisations and by R&D-based companies, *seeking to learn* in order to improve their institutional performance and the preconditions for institutional *survival* or even growth (*functional* assumption) and to contribute to socio-economic *modernisation* (*normative* assumption). In doing so S&T and political actors find themselves confronted with

- given general *issues of innovation policymaking* (public and private policy), moulded by the emerging and constantly changing role of S&T and innovation in economy and society (as sketched in section 1.1 above),
- given *arenas and configurations* with other actors in terms of resources (financial, knowledge), and of regulations and institutions (political, economic), partly determining and partly facilitating their actions.

Arenas and Actor Configurations

Assumption 1: A linear model of policymaking as a consequential process (typical steps: formulation, agenda setting, decisions, implementation, evaluation, formulation ...)[13] is no longer appropriate, at least not in the field of S&T policies. Here, all typical steps are more or less interacting, thereby describing "loops"[14]: Ideally, *looping policy processes* provide "stopping points" where policy-shaping activities converge in a way that effective acting is feasible (see figure 1.1).

Entry options for SI could be found at (1) such stopping points, (2) ad hoc opportunities, or (3) if it has been institutionalised as a steady monitoring process. The emergence of SI knowledge as a policy resource on the one hand and structural and institutional preconditions of using SI activities on the other influence and transform

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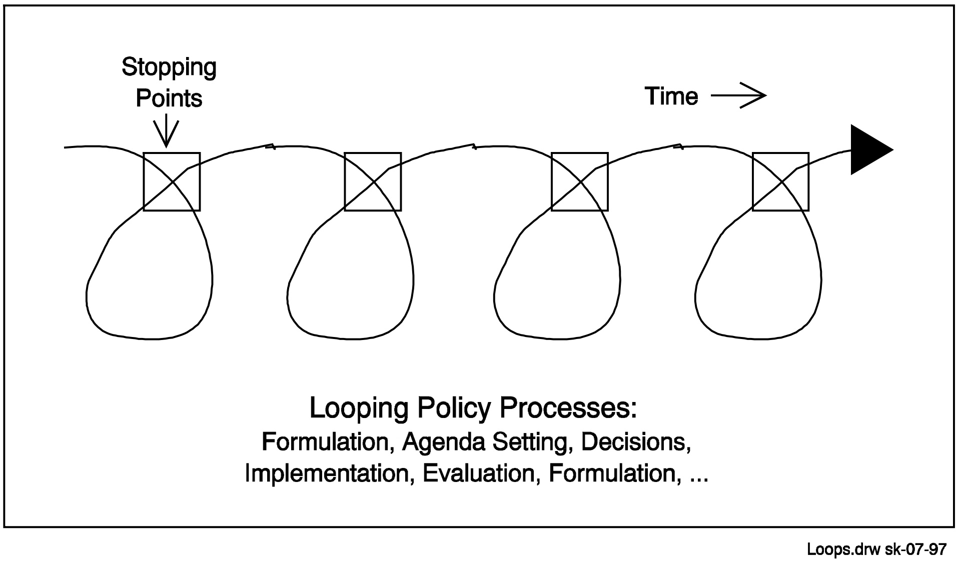
13 See e.g. Brewer, G.D./de Leon, P. (1983): The Foundation of Policy Analysis, Homewood, Ill., 17-21

14 Y. Dror discussed already 30 years ago - though in the context of a rationalistic and quite sophisticated policymaking model – the many communication and feedback loops that connect all the phases and subphases of optimal policymaking with each other (Dror, Y. (1968): Public Policy-making Reexamined, San Francisco/CA (Chandler), 191f).

each other. Often it is external pressure on policy actors and the related arenas that gives the impulse for the production and application of advanced SI.

Figure 1.1: Looping Policy Processes



Assumption 2: Innovation policy is rather (and increasingly) a matter of networking between heterogeneous (organised) actors instead of top-down decisionmaking and implementation. Policy decisions frequently are negotiated in *multi-level/multi-actor arenas* and related actor networks[15]; given power structures and the shape of arenas, nevertheless, may vary considerably between member states (or regions) or corporations (see figure 1.2). "Successful" policymaking normally means compromising through *alignment* and "re-framing"[16] of stakeholders' perspectives.

Assumption 3: Negotiating actors pursue different - partly contradicting - interests, represent *different stakeholders perspectives*, construct different perceptions of "reality"[17], refer to diverging institutional "frames". Different actors having different responsibilities (policymakers define programmes, allocate budgets; researchers define themes, purchase equipment; industry looks for competitive advantages ...) perceive different "stopping points".

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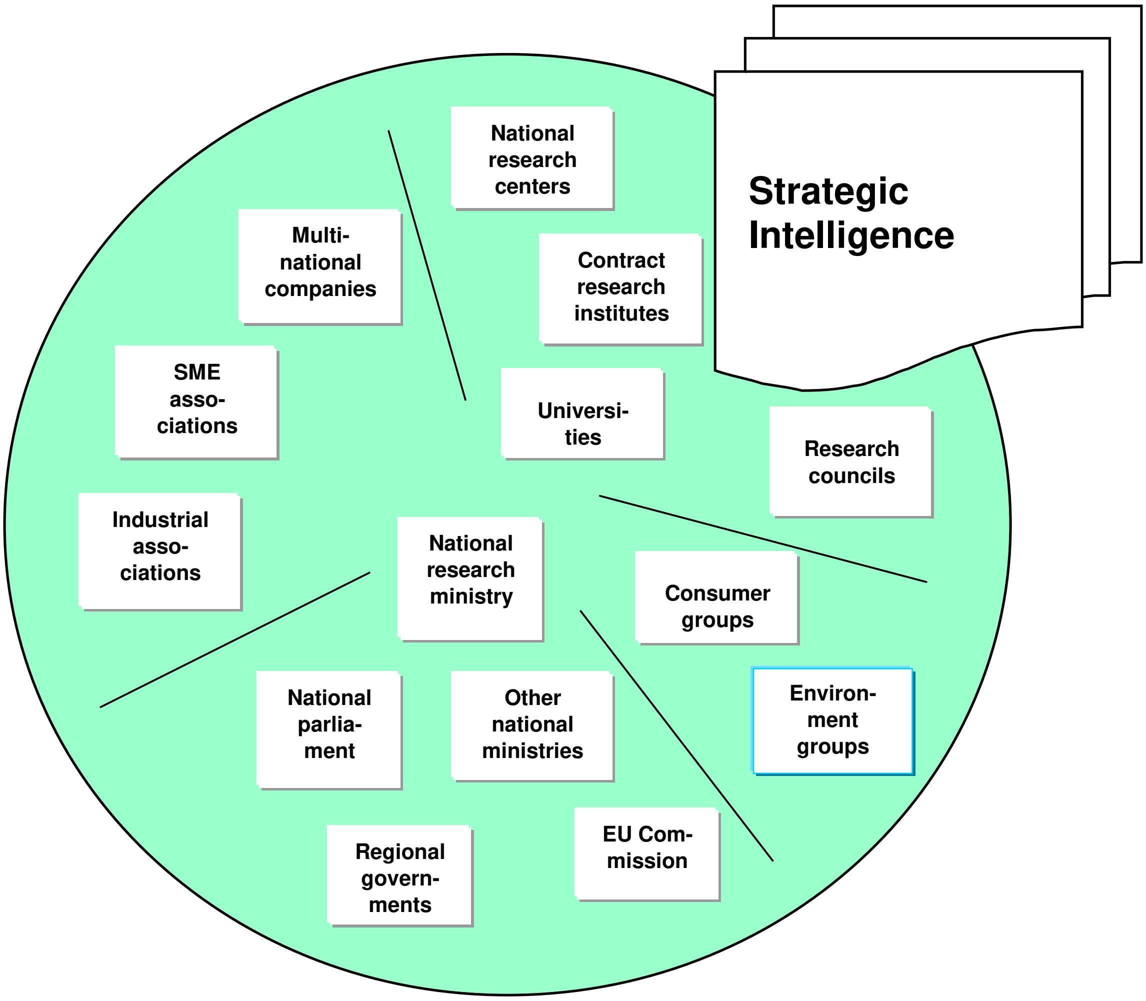
15 See e.g. Marin, B./ Mayntz, R. (1991): Policy Networks. Empirical Evidence and Theoretical Considerations. Frankfurt/Main und Boulder/Colorado (Campus; Westview Press).

16 See Schön, D. / Rein, M. (1994): Frame Reflection. Toward the Resolution of Intractable Policy Controversies, New York (BasicBooks). The conditions under which this works with innovation policymaking are discussed by Kuhlmann, S. (1998): Politikmoderation. Evaluationsverfahren in der Forschungs- und Technologiepolitik, Baden-Baden (Nomos); Laat, B. de (1996): Scripts for the future. Technology foresight, strategic evaluation and socio-technical networks: the confrontation of script-based scenarios, Amsterdam (PhD thesis).

17 See e.g. Callon, M. (1992): The Dynamics of Techno-Economic Networks. In: Coombs, R. / Saviotti, P. / Walsh, V. (eds.): Technological Change and Company Strategies: Economic and sociological perspectives, London et al. (Academic Press Limited), 72-102

Figure 1.2: Actors in Innovation Policy Arenas and Strategic Intelligence



Assumption 4: Contesting and negotiating actors use money, power and information as their main media. Various actors have different shares of these resources at their disposal. *SI tools* (policy evaluation; technology foresight; technology assessment) use in particular *"information" and knowledge as negotiation medium*[18]. Possible *variables* of arena *configurations* are the size of arena, related policy issues (e.g. distribution of resources; industrial; ethical/cultural), hampering or fostering institutional environments, the degree of self-organisation and of power of actors, or established routines and traditions, and the stability of configurations. Within different "configurations" *SI activities* may fulfil certain *functions* including

- analyses of changing innovation processes, the dynamics of changing research systems, changing functions of public policies;

18 A related concept of policy analysis is provided by Kuhlmann, S. (1998): "Politikmoderation". Evaluationsverfahren in der Forschungs- und Technologiepolitik, Baden-Baden (Nomos).

- the identification of diverging "frames" of actors' perceptions;
- a more "objective" formulation of diverging perceptions of (even contentious) subjects, offering appropriate indicators and information-processing mechanisms;
- the organisation of mediation processes and "discourses" between contesting actors (or between representations of their views).

Assumption 5: Is there anything specific about *SI for innovation policy?* Yes, research and innovation are open-ended activities, throwing up novelties. Thus, the results of R&D evaluation and the efforts on TF and TA *cannot produce automatically clear-cut alternatives* for policymakers' decisions (for example, because of life cycle of research issues, research groups and institutes). This is particularly, and sometimes dramatically, visible vis-à-vis the consequences of scientific or technological breakthroughs.

How can the implications of these assumptions be taken up in innovation policymaking? Putting it abstractly, *alignment and consensus* production is a precondition for *successful policymaking*. Innovation policy decisions are taking place in multi-level/multi-actor arenas and related actor networks and thus no actor can easily make his/her own interests/objective/actions prior to those of the others. In addition, TF, EV and TA rely on the input of experts and existing organisations and are increasingly considered as tools to create alignment between actors (cf. foresight triangle in which foresight methods are positioned between the three poles of expertise, creativity and interaction).

Does the alignment process *foster or prevent "revolutionary" decisions?* Governments and others now and then try to force such decisions: examples are the Task Forces of the EU, the Technological Centres of Excellence ("Technologische Top Instituten") in the Netherlands[19], and probably also the UK White Paper. These are breakthrough policies that initialise new patterns, activities, aggregations within the innovation system, changing existing institutes or setting priorities and posteriorities[20]. There is a *paradox*: the legitimisation of these breakthroughs partly comes from the outcomes of evaluations of the performance of institutes or analyses of national systems of innovation. Strategic Intelligence may, however, create also broader "roadmaps" orienting actors towards a more conscious decisionmaking exceeding "conservative" alignments.

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19 When initiating the idea of TTI the Ministry of Economic Affairs in the Netherlands deliberately tried to circumvent existing actors, esp. the traditional scientific organisations and give industry a large say in the selection and management of the TTIs. However, at the time the idea had to be made concrete more and more the TTI idea changed from a new (brick-) institute to a (network) institute combining groups from universities, TNO and industry. It is remarkable that eventually the Royal Academy played a key role in the selection of the institutes.

20 The idea of posteriority might be a good entry for thinking about why revolutionary decisions are hard to make and if and how SI could contribute to such decisions.

1.3 User Needs for Distributed Intelligence

Summing up the assumptions sketched above, a basic presumption of this report is that the functional acts of policymaking and decisionmaking are improved via access to "relevant information" or "strategic intelligence". This is linked to the presumption is that "societal policy aggregation and formulation" (i.e. the total set of policymaking activities which take place at many organisational levels within complex societal structures) is enhanced if this "Strategic Intelligence" is "distributed" around these societal structures in such a way that it can be easily accessed and used by all or most interested parties – which includes public sector policymakers, private sector decisionmakers and all those affected by the resultant policies and decisions made by these actors. This latter presumption, however, is one that can only be examined via a closer look at user needs for strategic and distributed intelligence.

Within complex social structures, the range of potential users of "Distributed Intelligence" is as vast as the variety of needs this intelligence is meant to satisfy. These needs also change over time. Within public policymaking circles, for example, policy has evolved from "science policy" to "science and technology policy" and latterly to "innovation policy", with a corresponding shift in policy emphasis from "science push" to "market pull" and latterly to a realisation that "variable geometry" policy mixes are needed to "manage" complex "innovation systems". Accordingly, the information and intelligence needs of policymakers located within these innovation systems have evolved apace. Nowadays innovation systems are conceived as complex social interactions between multiple actors, with single policy interventions having multiple causes and an equally diverse set of consequences.

In such situations, choosing appropriate policy interventions is problematic and dependent on a substantial degree of understanding of both likely causes and consequences. Policy actors thus have an urgent need for "intelligence" which is timely, comprehensible, relevant to their needs and of sufficient quantity and quality to temper their decisions with a healthy dose of rationality.

To a large extent user needs for strategic intelligence are a function of their spatial, institutional and organisational location within "innovation systems" and related policy arenas (defined as "configurations", in section 1.2 above). The intelligence needs of public officials setting broad S&T agendas at the level of the European Commission, for example, are likely to be different from those within the same organisation responsible for the operational management of such programmes. Similarly, the needs of these EU-level actors will differ from those responsible for national and regional S&T policies and programmes, and the needs of all public-sector actors are likely to differ radically from those within private sector organisations responsible for setting strategic directions for their organisations. Neither should the needs of the general public be forgotten within increasingly participatory democratic structures.

Since the intelligence needs of different actors are highly specific and "localised", it is tempting to conclude that these needs can only be satisfied via highly customised intelligence gathering and problem-solving exercises – all differing radically from one organisational and spatial setting to another. It is this reasoning which has led in the past to the commissioning in different settings of many highly focused and individualistic intelligence gathering exercises, with the choice between evaluation (EV), Technology Foresight (TF) and Technology Assessment (TA) studies dependent upon customer preferences vis-à-vis a desire either to review past actions, respond to current events or to assess future options.

This practice of commissioning highly individualistic exercises has been reinforced in the past by the influence of "disciplinary" and "cultural" factors. There has, for example, been a tendency over the last twenty years or so for EV, TF and TA to be conceived of as independent "disciplines" or "schools", with fairly well-defined spheres of interest and operation. Although some conceptual links do exist between these schools, in practice their intellectual development has tended to be along separate tracks.

There has also been a tendency for the practices associated with the conduct of EV, TA and TF to be culturally differentiated. It is possible, for example, to identify a very Dutch brand of TA, and EV orientations which differ radically as one moves from Northern to Southern Europe, with heavy emphasis in the North on "objectivity" and the production of written evaluation "outputs", and a greater emphasis in the South on "process" aspects which encourage beneficial interchanges between evaluators and the evaluated.

This conceptual and spatial plurality is healthy in many respects, not least because the needs of the customers for EV, TF and TA do vary from one locality to another. As customer needs evolve and change, however, there can be no guarantee that the EV, TA and TF practices which emerge in one particular setting can or should remain the most appropriate ones to employ. We know, for example, that the needs of customers for evaluations and other exercises change over time. In the early 1980s there was a demand in the UK for summative evaluations, which would demonstrate, value-for-money and satisfy the imperatives of accountability. Later in the decade, demand grew for formative evaluations, which started to integrate evaluation with strategy formulation, and currently there are some signs that the pendulum has started to swing back with an increasing interest in "benchmarking" exercises.

As customer needs change, the practitioners of EV, TA and TF need to evolve too, modifying methods and approaches in line with demand. There has been a tendency in the past for many government S&T agencies to exploit indigenous expertise in the organisation and conduct of national S&T programme evaluations. There is no obvious reason why this should continue, however. Just as large firms look to global markets to satisfy their needs when local suppliers fail to deliver the desired goods, government agencies can (and have started to) look elsewhere. Agencies in European countries such as Sweden, Finland, Norway and Ireland, for example, regularly ask for evaluations to be conducted via internationally oriented "evaluation missions", i.e. evaluation exercises which tap into international sources of evaluation and technological expertise rather than purely local sources. Provided by organisations prepared to operate globally and to draw on a vast, international pool of expertise, evaluation missions offer government agencies the chance to sample and explore evaluation methods and approaches not always available locally.

Strongly embedded within the concept of distributed intelligence is the notion that "localised" user needs for strategic intelligence can be best met via the adoption of global best practice intelligence gathering methodologies[21]. Part of the rationale for the ASTPP workshops was a recognition that too rigid a conceptual compartmentalisation of EV, TA and TF was inappropriate in this day and age, primarily because such a static construction would fail to meet the evolving needs of European policymakers. These needs will also be ill met if "local" EV, TA and TF practitioners fail to realise that "local" approaches may no longer be appropriate and that there is a need for best practice approaches to spread from one country to another via mechanisms such as evaluation missions.

Also implicit in the concept of distributed intelligence is the notion that the results of specific localised exercises can be, and are increasingly recognised to be, pertinent to policy formulation elsewhere in the world. This is particularly so for evaluation and foresight exercises. Although not central to the needs of "local" policymakers, the results of similar exercises in different parts of the world comprise a valuable contextual backdrop against which the results of customised intelligence exercises can be compared. These are precisely the user needs that can be satisfied via the elaboration of a system architecture for distributed intelligence within European and global innovation systems.

For many policy actors within innovation systems, the *need to access* comparative contextual data produced via the *strategic intelligence exercises of others* is becoming a necessity rather than a luxury. The complex dynamics of innovation systems in part demand a *pooling and sharing* of such data in order to avoid expensive duplication of effort. The same complexity also means that there are few tried and tested policy formulae that can be adopted and applied, with many policy initiatives constituting risky experiments unless guided by intelligence reports concerning the fate of similar initiatives in other parts of the world. Current user needs for strategic intelligence may still have a strong local focus, but there is little doubt that the need for access to a *system of distributed intelligence* is increasing.

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21 Of course a tension exists between the need to be "close to users" and the need to make as much use as possible of more generic knowledge. In our opinion however this doesn't provide us with an unresolvable dilemma. It is far more a challenge for the analyst to find the right balance. This not only for the sake of reducing costs but also in order to add value to local strategic intelligence by placing local events and questions in a broader context.

1.4 Basic Elements of Improved Strategic Intelligence

In the preceding sections we have tried to demonstrate that a growing need exists for strategic intelligence to underpin policymaking in the area of science, technology and innovation. We have also indicated that it is not necessary to start from scratch when attempting to meet these needs. In the past a whole array of instruments have been developed to provide strategic intelligence. Among the best known are the three strategic intelligence tools discussed in detail in this report: evaluation, foresight and technology assessment. The use of these tools, however, could be improved considerably, as could access to the results of exercises which employ them.

Box 1.1: **Examples of infrastructures for distributed intelligence: Technology Arsenal management**

In his report issued in 1994 entitled 'Technologiebeleid en Economische Structuur (Technology policy and economic structure)' the Dutch advisory Council for Science and Technology (AWT) introduces the concept of technology arsenal management. The AWT stresses the need for SMEs to develop a clear strategy regarding the products and services they want to produce and the expertise necessary to do so. The next step then is to look in the outside world for already available expertise and use this expertise to develop the intended new products and services. In other words, SMEs not only should strengthen their capacity to develop market-strategies but also strengthen their abilities to manage the available pool of expertise in such a way that they get access to knowledge relevant for the realisation of their strategy. It will be obvious that following this route is almost at right angles with the more traditional, linear technology transfer approaches.

Basically there are two parallel and complementary routes which can be taken to improve the quality, efficiency and efficacy of strategic intelligence.

The first involves *improvements* in the use and deployment of *existing instruments and tools.* A great deal could be gained via the further development of these instruments and via their use in interesting new combinations, either with each other, e.g. combined evaluation and foresight exercises feeding into strategy development, or, alternatively, via comparison of the results of the parallel use of the same instruments at different levels (e.g. national vs. international) or in different places (national vs. national).

That there is potential for *further developing* these instruments is perhaps demonstrated by the extent of developments to date. TF and TA, for example, have changed considerably over the last three decades, with forecasting (prediction) being supplanted by foresight (scenario construction)[22], and TA metamorphosing from an "early warning system" into a policy instrument capable not only of identifying possible positive and negative effects, but also capable of helping actors in innovation

22 See Irvine, J. / Martin, B. (1989): Research Foresight: priority-setting in Science, Pinter Publishers, London and New York.

processes to develop insights into the conditions necessary for the successful production of socially desirable goods and services[23].

A relatively new trend has been the development of tools which not only provide useful strategic intelligence, but which also enhance innovation processes themselves by allowing the actors involved to interact in different ways. IT-supported group decision rooms[24], consensus development conferences, and platform and scenario workshops are all examples of these new tools. In fact, the existence of this new trend emphasises the shift from analytical to more process-oriented instruments, a shift which takes into account the growing complexity of innovation systems and the need for assistance in strategy development to go beyond the provision of empirical data on the development of new technologies.

Box 1.2: ***Examples of infrastructures for distributed intelligence - Filiere policy in the Alsace***

A second illustration can be found in the "filiere policy" as developed in the French region Alsace. The policy is geared to small (<20 employees), traditional firms and tries to motivate firms to organise a common strategic reflection, with the help of consultants for the preliminary audit of the sector and then to decide for collective strategic options (and possibly also material and immaterial infrastructures). This demonstration of communication and "self- organising capacity" is a necessary precondition to get financial support. Also this policy is an example of what could be called "second generation policies". Crucial element of this second generation is the focus on strengthening the strategic and managerial capacities. As a consequence, SMEs not only need technical expertise but also expertise related to organisational and marketing issues. Because this category of SMEs does not possess the critical mass to fulfil such functions on their own, they also should increase their capacity to organise themselves in strong and effective networks.

The second route to improved strategic intelligence leads us to the critical concept of *Distributed Intelligence (DI).* Underpinning this concept is the notion that policymakers - and other actors involved in innovation processes – only use or have access to a small proportion of the strategic intelligence of potential relevance to their needs, or to the tools and resources needed to provide relevant strategic information. These intelligence tools, resources and outputs exist within a wide variety of institutional settings and at many organisational levels, but are scattered all over the globe. Consequently they are difficult to access and use. Rectifying this situation will thus require major efforts to develop interfaces stimulating the accessibility of already existing information, and to convince potential users of the need to adopt a broader perspective in their search for relevant

23 For an analysis of this change in relation to the shift in innovation policies from supply-oriented towards user-oriented approaches see Smits R. / Leyten, J. / den Hertog, P. (1995): Technology Assessment and technology policy in Europe: new concepts, new goals, new infrastructures. In: Policy Sciences (28), 272-299.

24 For the potential role of ICT supported group decision systems in user-oriented decisionmaking on technology see for instance Bongers, F. / Smits, R. / Geurts, J. (1999): Technology and society: GSS-supported participatory policy analysis accepted for publication by the International Journal of Technology Management; Breiner, S. (1997): Die Sitzung der Zukunft, Heidelberg (Physica/Springer).

intelligence expertise and outputs.

Consequently, the architecture and infrastructures of Distributed Intelligence must allow access, and create *inter-operability* across locations and types of intelligence, including a *distribution of responsibilities* with horizontal as well as vertical connections, not (exclusively) hierarchical, thus also limiting the public cost of DI and strengthening the "robustness" of its infrastructure.

Furthermore, the robustness presupposes provisions for *quality assurance*, thus underpinning the trust in DI based debates and decisionmaking.

Having introduced two routes to stimulate and improve strategic intelligence, the next step is to consider their operationalisation and implementation. In particular, what kind of infrastructural requirements arise and have to be met in order to facilitate the use of new combinations of strategic intelligence instruments and improved utilisation of a system of distributed intelligence.

1.5 Résumé: General Requirements for Distributed Intelligence

Summing up and in order to justify the direction we take in this report, we have to stipulate a number of general principles of Distributed Intelligence for complex innovation systems.

General requirements of Strategic Intelligence are:

- Organize mediation processes and “discourses“ between contesting actors in related policy arena
- Inject policy evaluation, foresight and TA results, also analyses of changing innovation processes, the dynamics of changing research systems, changing functions of public policies
- Realize thereby the multiplicity of actor's values and interests
- Facilitate a more “objective” formulation of diverging perceptions by offering appropriate indicators, analyses and information-processing mechanisms
- Create forums for interaction, negotiation and the preparation of decisions
- Respond to the political quest for democracy vis-à-vis technological choices

Since innovation policymaking occurs in multiple policy arenas on regional, national, European levels there is a need for "interfaces", linking different systems and related policy arenas. General requirements of Improved Strategic Intelligence *Infrastructures based on Distributed Intelligence* are:

- Create an architecture of "infrastructures" for Distributed Intelligence – but no one unique "system"!
- Link – via SI infrastructure – the existing regional, national, sectoral etc SI facilities, horizontally and vertically
- Build brokering "nodes" managing and maintaining the infrastructure
- Establish a "enabling structure" allowing free access to all SI exercises undertaken under public auspices. Thereby the "pedigree" of information transferred through the infrastructure must be traceable
- Offer a "directory" facilitating direct connections between relevant actors
- Define clear rules to access the infrastructure
- Make the infrastructure robust, able to survive; guarantee adequate resources

General requirements for related *quality assurance* mechanisms are:

- Facilitate repeated and "fresh" exercises (e.g. EV, TF, TA) and new combinations of actors and levels
- Enhance and ensure professional quality of SI and DI production, including registration and accreditation of professional practitioners, and mechanisms to stimulate renewal

Measured against these principles, the present situation, however promising developments will be shown in the following chapter 2, is not adequate. There are reasons to design an improved distributed intelligence.

2. Basic Concepts of Technology Foresight, Innovation Policy Evaluation, Technology Assessment and Seeds of Combined Approaches

Roughly, one can describe the basic concepts of Technology Foresight, S&T Policy Evaluation, and Technology Assessment in the following way:

- "Technology foresight is the systematic attempt to look into the longer-term future of science, technology, the economy and society, with the aim of identifying the areas of strategic research and the emerging of generic technologies likely to yield the greatest economic and social benefits"[25].
- Practices of S&T policy evaluation are wide-ranging, and their functions vary significantly (1) from the provision of legitimation for the distribution of public money and the demonstration of adequate and effective use of the funding by measuring the scientific/technological quality or the (potential) socio-economic impacts, via (2) targeting and "controlling" in the sense of improved management and "fine tuning" of S&T policy programmes, to (3) an attempt to improve transparency in the rules of the game and the profusion of research funding and subsidies, and to enhance the information basis for shaping S&T policies, in the sense of a government-led "mediation" between diverging and competing interests of various players within the S&T system[26].
- Technology assessment: In very general terms, TA can be described as the anticipation of impacts and feedback in order to reduce the human and social costs of learning how to handle technology in society by trial and error. Behind this definition, a broad array of national traditions in TA is hidden[27].

On the following pages we summarise the experiences gained so far of the performance of TF, EV and TA in decisionmaking processes of S&T policies. Since the understanding of the three analytical tools varies considerably, not only from country to country, but also from one institution to another, any attempt at a systematic description of existing definitions and practices would far exceed the scope of the present report. We concentrated our efforts therefore on basic experiences across

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25 Martin, B. (1995): Foresight in Science and Technology. In: Technology Analysis & Strategic Management vol. 7, no. 2, 140.

26 See e.g. Kuhlmann, S. (1997): Evaluation as a Medium of Science & Technology Policy: Recent Developments in Germany and Beyond. In: OECD (ed.): Policy Evaluation in Innovation and Technology, Towards Best Practices. Paris, 443-460.

27 See e.g. Schot, J. / Rip, A./ (1997): The Past and the Future of Constructive Technology Assessment. In: Technological Forecasting and Social Change 54 (1996), 251-268; see also International Journal of Technology Management (1996): Special Publication on Technology Assessment (Guest editor: Denis Loveridge), Vol. 11, Nos 5/6

countries and institutions, while illustrating the given variety of practices and contexts through a number of cases.

The chapter will finally lead to the identification of some seeds of combination of TF, EV and TA in decisionmaking processes of S&T policies, providing starting platforms for advanced concepts of "Distributed Intelligence".

2.1 Science and Technology Foresight

Science and Technology Foresight exercises are becoming increasingly attractive for governments, national research agencies and businesses in their efforts at coping with increasing complexity of new technologies and decision environments, in an increased techno-economic competition world-wide[28].

TF could be presented as a new type of technology policy tool ... if it were really an innovation. In exact terms, the newness is not the tool, but the fact that TF is done explicitly and involves more people. The techniques existed and policymakers only decided to (re-)use them in a situation of great needs: faced with the necessity of making choices while confronted by increasing competition in the globalized world of the nineties, and then starting to think in terms of division of labour for science and technology. On the private level, during the entire post-war period, large firms and other organisations have never ceased to use TF as an element of their strategic management process. Now policymakers and experts of various institutions are increasingly involved in a new type of policymaking mechanism and negotiation process, supposed to facilitate the creation of consensus and commitment among them on a large scale.

The actual uses made of TF exercises have not yet been studied and evaluated sufficiently. This is one of the areas for future research in the field. Still, first hand experiences of the exercises indicate many positive effects and in some cases even enthusiasm from those participating in the process. Nevertheless, there is a need for thorough cost-benefit analyses because TF exercises are expensive and, especially if large-scale consultative processes are being used, cumbersome procedures. Furthermore, in some cases, national TF programmes have been performed without enough consideration of the uses of the results and the necessary follow-up actions. The problem at hand is that, as a cognitive creation, TF cannot be considered as a final aim or output (in contrast to scientific discovery, for instance) and supposes political continuity, plus commitment to implement the results in some sense.

The majority of experts consider TF essentially as a collective and consultative process, with the process itself being equally or even more important than the outcome.

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28 See the overview in e.g. Grupp, H. (1998) (ed.): Technological Forecasting & Social Change; Special Issue on Recent National Foresight Activities, Vol. 57.

National TF programmes are ways of obtaining opinions, conflicting or otherwise, about future developments, most of which are already established. TF in this sense is an essential contributor to the creation, either collectively or individually, of models of the future. Models of the future are important because they are capable of creating synthesis, they are disruptive and interfere with current modes of thought, thus forming and shifting values.

Many experts are convinced (but this is not a general opinion) that gains could be obtained if TF exercises were carried out at the European level. In particular, smaller countries might profit from joint efforts at the European level, since the use of large expert panels such as in the Delphi exercises is a costly and cumbersome tool. However, even for the larger countries, the national level may not be the most relevant context. Countries or "intermediate level" actors such as regions, which have not yet conducted national (regional) TF exercises, could benefit from learning the techniques in joint efforts. Care should, however, be taken not to ignore national differences and other differences of context. This requirement would make European level exercises very complicated. Still, such exercises would probably be fruitful provided the European level is intelligently articulated with the lower levels and, in particular, if such exercises enrol the experience of the European TF "champions".

Examples of S&T foresight experiences:

(1) The UK Foresight Programme. *The UK Foresight Programme provides a rare example of TF becoming deeply embedded and institutionalised within the national innovation system rather than operating only at a higher strategy-making level. The Programme began in 1993, having been announced as the centrepiece of a Government White Paper on Science, Engineering and Technology, which itself was seeking to greatly improve the connections between the national science base and its users, notably in industry. From the outset the TF Programme (as it was initially known) combined this objective with that of informing priorities for public spending on science and, implicitly, promoting a "TF culture" more broadly.*

The first cycle of the programme began in September 1993 with the appointment of a high-level Steering Committee. The pre-TF stage (to April 1994) involved identifying and briefing members of the 15 panels which, together with the Steering Committee, would be the mainstay of the programme. Panels were drawn principally from industry, combined with academic and government membership. Indeed, a notable feature of the Programme has been the high level of support and participation from industry throughout. It has been postulated that this resulted from the increasing dependence of firms upon external sources of technology to the point where formulation of strategy, previously an internal activity, must now at least in part be carried out in the public arena. By collaborating in their thoughts about the future, organisa-

tions may be better placed to anticipate the actions of their customers, suppliers and others, such as regulators, who may influence the environment in which they operate[29]. Efforts were made at this stage to broaden the base of participation beyond that of regular advisers to government.

In the main stage of the TF activity, panels identified key issues and trends, developed scenarios for their sectors and consulted widely, by means of a Delphi survey, regional workshops and contact with other parties. The process culminated in the production of a report by each panel and a Synthesis Report by the Steering Committee. The latter prioritised the recommendations of the sectoral panels in a matrix which plotted attractiveness of the potential economic and social benefits against the feasibility of the science and technology involved, with the ability of the UK to achieve the result a key consideration in both cases.

After the reports were published, the Programme entered its second phase in which the main objective was to disseminate and act upon the results through media, workshops, professional and trade associations, among others. Some 600 events were held and 130,000 reports disseminated. The panels were retained to drive this process, though with some adjustment in terms of reference and membership. The most direct follow-up was a new funding initiative, the TF Challenge fund, which supported 24 academic-industrial projects related to TF priorities with ECU 50 million of public funds and ECU 93 million of private sector contributions. Existing budgets for science were also influenced, though it is much harder to establish attribution here. An official estimate gave 54% of Research Council spending as being aligned with TF priorities, of which ECU 450 million was for new initiatives. Other government departments carried forward areas relating to their own remits, for example transport and environment.

In 1997/98 the third phase of the Programme gave top priority to the wider engagement of business, with the top priority being to increase business participation beyond R&D divisions to reach those involved in corporate strategy, marketing and finance. This was one reason why the term technology was dropped from the title. Other activities at this phase included efforts to improve co-ordination across government departments and to begin preparation of a new cycle of TF activity. Both the Steering Committee and the Panels were reconstituted as networks of implementing organisations. With the wide range of linkages across the whole of science and innovation policy the Foresight Programme can be said to have been re-invented as a brand and binding agent for innovation policy in the UK.

In evaluating the successes and problems of the Programme, on the positive side there was a clear success in attracting widespread support in industry

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29 Georghiou L. (1998): The UK TF Programme, Futures, Vol.28, No.4, pp359-377

and much of the science base. While the priorities which emerged were rather broad, they have been generally accepted. There is a recognition that these are priorities for follow-up action, not an attempt to second-guess scientific creativity. The networking activities have universally been seen as beneficial and become more prominent as an objective over time.

Problems encountered included a rather rushed time scale for Phase 1 which inhibited the development of mature recommendations and the ability to take full advantage of the methodologies. While the panels mostly worked well, barriers of communication emerged between members and the rest of the community and between the panels themselves. This has led to the conclusion that the next cycle should have a more cross-sectoral approach and more permeable structures. In terms of participation, there was a step change upwards in the numbers involved, but these still were all in the expert community and did not include the wider public. Excessive focus on technology as a driver led to over-emphasis on technical fix solutions relative to regulatory or social change.

At the time of writing, proposals for a new cycle of TF activity from 1999 involve several changes and developments, partly to capitalise upon experience and partly to avoid a repetition of the previous findings. As well as the more open structures mentioned above, it is proposed that there should be a mixture of sectoral panels as before, and thematic panels on cross-cutting topics such as the ageing population, future cities, crime control and social cohesion. A further innovation is the establishment of a "knowledge pool", a professionally managed electronic library which draws together contributions from the community and provides a common resource. The devolved nature of the new cycle does not include any centralised surveys, Delphi or otherwise, though individual panels may pursue these.

(2) Foresight efforts in enterprises. *One of the ASTPP workshops raised the question: "Is there industrial need for TF and strategic technological intelligence?" The answer of the participating companies was quite clear: Yes, more than ever, since the high degree of focus in companies tends to produce narrow thinking. The result is a lack of innovation, to the point where useful innovations cannot be recognised. Two techniques, "scanning" and "monitoring", were described. The first relates to looking for information, but not within the limits of existing "tunnel vision". Monitoring follows trends in defined frameworks that lead to practical strategies. But TF efforts are only one of many factors of strategic decisionmaking! Furthermore, enterprises understand strategic technological intelligence as an integrated bunch of various methods and measures. There are two key requirements: (1) any TF procedure should ease communication, interaction, networking, exchange of those responsible for various elements of innovation; (2) furthermore, TF exercises* *should deploy "distorting mirrors" facilitating the creation of new combinations of knowledge and experience embodied in heads or technologies.*

There is no general TF model in industry. SMEs perform TF, if at all, implicitly, i.e. without formal procedures and explicit investments; many large corporations, on the other hand, organise TF efforts rather explicitly! One should differentiate the functions of industry-internal vs. public TF initiatives: Industrial TF initiatives are done for survival and growth, while public activities initiated by governments can help to create awareness, to provide legitimisation for company-internally "revolutionary" discourses and for prioritising of investments. Large corporations use public TF exercises as just another information source, while SMEs tend to take advantages from it (if at all) embedded in broader public support initiatives.

(3) ***Regional foresight initiatives: The Bordeaux Case.*** *The example of Delphi Technopolis in the Bordeaux region shows possibilities, but also difficulties of the use of TF exercises at the regional level[30]. As in the case of the national Delphi, where experts expressed a certain resistance to dealing with the originally Japanese list of topics (the French national experience used the Japanese Delphi as a model), the regional experts did not very easily accepted the national survey, because of the high proportion of topics they felt irrelevant for their own (or the regional) context - although they had the possibility to add their own topics to the questionnaire. The experts' critique has also been formulated in a slightly different way: "In designing the regional Delphi, why have you not taken into account the existing local networks instead of imposing such an external (understand: irrelevant) view?" Every TF experience, by definition, builds a new network of communication and aims at creating novel networks of actors, around new projects and new combinations of existing competencies. And, by definition, it hurts existing networks. These organised local groups will probably be involved in the subsequent phases, for the choice and the implementation of any regional strategy of development, but we consider it here as an advantage to start the process with a more neutral view, coming from a higher (national) or external (foreign) level.*

The second sort of problem we want to underline in the Delphi Technopolis experience is related to the legitimacy and/or credibility of the operator. Shortly before the end of the project, the science park organisation Bordeaux-Technopolis decided to link the regional Delphi with the freshly issued results of the other large national technology survey, managed by the Ministry of Industry and focusing on "critical technologies" for the French productive sys-

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30 Bordeaux Technopolis/ BETA/ IERSO (1997): "Delphi Technopolis", Conseil Général de la Gironde, Bordeaux, France

tem. Among the reasons, we can stress the general characteristics of the latter national survey: medium-term TF in a demand-oriented approach. But the decisive argument for adding that national survey to the regionalised TF experience was the fact that the Ministry of Industry had more credibility (commitment to re-frame the ministry's subsidies system along the critical technologies' grid given by the survey) than the less powerful Ministry of Higher Education and Research responsible for the national Delphi.

Another limitation of the Delphi project is linked to the relatively weak institutional status of the operator, Bordeaux Technopolis, among the actors of the regional scene. The follow-up of the project has been taken over by the association of the four main actors (the Regional Council and the three local administrations of ANVAR, DRRT, DRIRE, respectively for the National Agency for Technological Diffusion and the Ministries of Research and of Industry). Nevertheless, the catalytic function of the science park organisation must be recognised: without its initiative, the joint initiative of the four main actors in the science and technology regional scene would not have been set for such a global TF procedure.

One of the general methodological conclusions that have been drawn by the actors of that regional experience is the importance of the context. The acceptability of the whole set of items to be examined in such a survey is one component of the context: the regional experts can be discouraged if too many of the items are felt irrelevant to be - or only badly known. In terms of information diffusion, and concerning the " raising awareness " function that any form of TF procedure involves, it means that a sort of optimal trade-off must be reached between bringing too little and too much novelty to the experts, when translating the TF experience from the upper level to the lower one. The second contextual aspect deals with the credibility / legitimacy of the institution performing (directly or indirectly) the experience: it proved to be crucial to link TF with power and commitment to act.

Summary and conclusions

(1) TF has *standard methods*, used for decades in public as well as private contexts. They are still improving, and the evolution lies also in the art of combining them adequately: Delphi, workshops, specific surveys, seminars, etc. But the newness is more in the fact that policymakers have recently decided to use these explicit methods of TF more systematically (instead of opaque bureaucratic decision processes).

With explicit professional methods of TF, more people are involved: scientists, managers, consultancy firms, social partners, etc. In this respect, more *distributed intelligence* is enforced. Through their participation, all these various actors get information, do their own intelligence building and feed back their perceptions (and values) into the system.

Large explicit procedures are costly, but they improve the quality of the decision process also in another sense: allowing the reaction of various categories of "experts", they add dimensions of TA and EV to the "pure" TF exercise.

The possible action of the EU in this domain is to diffuse information on the best national practices and be a model by actively practising TF exercises.

(2) TF approaches are known and used by large private and public organisations. Private corporations often develop in-house TF exercises, as part of their strategic management process. They also participate in the large public exercises and/or they can use public TF results in their information/decision system.

The more challenging point is the *participation of SMEs*, since most of them have not the critical mass, the time or the competence to feed in or use TF information. Thinking of the ways to involve these actors in existing TF programmes or to adapt the tool for them is an important task to deal with. Our first ideas on that point are:

0 large diffusion of the results and interpretations of existing national/international TF experiences;

1 developing regional TF because they are closer to the needs and competencies of the SMEs;

2 involving consultancy firms and public agencies that play an important role in the environment of SMEs as strategic information transmitters and processors.

Here, the role of the EU could be to support such actions through information diffusion and co-financing regional projects.

(3) Distributed intelligence is an overarching concept of policymaking or management. In the case of TF, it means involving a large scope of actors and levels: public and private organisations, large and small units, national and regional institutions, experts and citizens, bureaucracy and politics, etc.

As an overarching political system the EU could play a specific role as a model-creating initiator, starting with the implementation of "distributed" (in the geographical sense) intelligence. Developing *a European TF programme is one possible option.* One can discuss its cost/advantage ratio for the European Commission's policymaking, its political desirability etc., but since TF is often more useful as a collective learning process than for its final output, any common European TF initiative would have a positive impact on European integration. By developing specific TF tools, the EU plays the role of a demonstration centre and a catalyst of communication within Europe.

(4) It is well known that big S&T breakthroughs have often not been forecast by a majority of experts. Some of them were nevertheless anticipated by individual thinkers. This is a classical problem of TF and other methods of "prospection": how to detect feeble signals or the minority views that could be revealed as the very precursors of the future? The *paradoxical nature of TF* tools is that they aim at two conflicting goals: *building consensus* and preserving *variety of visions*. The specific problem with administrative procedures is their natural bias towards selecting ma-

jority views (risk-taking is not the philosophy of administration - private or public). Distributed intelligence means here: combining views of heterogeneous relative weights.

This is a crucial issue for the EU because of, both: the size and complexity of its institutions that make administrative procedures particularly cumbersome - the permanent (welcome) insistence on the need to preserve variety within Europe adding to the necessity to keep variety of visions for all the various national contexts.

(5) The EU already has its own TF functionality, scattered in various locations. Some aspects are dealt with in an institution like the Institute for Prospective Technology Studies (IPTS), others are processed through the activity of several Directorate Generals, etc. Here, the *challenge is to circulate that "distributed" information available in European institutions* in order to build real "intelligence". How to make the activity of all the functional structures dealing with future trends in science, technology and innovation more transparent to each other and to external observers? Certainly, the *use of advanced information and communication technologies* is an opportunity to be seized.

2.2 Innovation Policy Evaluation

In European countries, an "evaluation culture" in S&T and innovation policies has evolved. In most countries there is quite a well developed system of ex ante EV of project proposals. Other forms of S&T policy EV, not yet quite as common, but increasingly used during the last two decades include

0 *ex post* EV of research programmes and other policy initiatives,

1 EV of R&D centres and universities,

2 EV of R&D funding agencies.

In all these cases, EV plays a different role in decisionmaking. It is directly and instrumentally linked to decisions in ex ante EV of proposals. The role of EV varies from case to case and includes, among other things, the following functions:

(1) EV may provide *legitimisation for the allocation of public money* to R&D.

(2) EV may enhance an adequate and effective use of funding by measuring the scientific/technological *quality* or the (potential) *socio-economic impact*.

(3) EV may improve programme *management* and "fine tune" S&T policy programmes.

(4) EV may provide new ideas or legitimate already circulating ideas about *changes in R&D centres and funding agencies*, thus enhancing the fulfilling of their missions.

(5) EV may be an attempt to improve *transparency of the rules* of the game of S&T funding decisions, and

(6) enhance the information basis for S&T policies, in the sense of a government-led *"mediation"* between diverging and *competing interests* of various players within the S&T system.

European countries differ in the extent to which they apply S&T policy EV. Some countries have longer traditions of EV cultures, others are relative newcomers in this field. In countries such as Greece, EU RTD programmes and their EV procedures have stimulated S&T policy EV exercises and helped train national experts in EV. For countries which are newcomers in the EU, the OECD has also played an important role in diffusing models of EVs. Scandinavian countries have exchanged models and ideas on EV as early as the 1980s in their mutual S&T policy collaboration.

The following cases illustrate how EV can be embedded in strategic planning in national research or innovation policy.

(1) The British ROAME system*: In the UK, the Department of Trade and Industry pioneered the ROAME process in mid 80s. This called for the full articulation, prior to the acceptance of a proposed programme, of the* ***Rationale*** *for the programme; its main* ***Objectives****; and the means to be used to* ***Appraise*** *project proposals, to* ***Monitor*** *developments and to* ***Evaluate*** *performance. Latterly, attempts have been made to expand the acronym to* ***ROAME-F****, where the additional 'F' corresponds to a* ***Feedback*** *loop linking EV results into the strategy development process for new programmes.*

ROAME has had the effect of embedding EV more fully into DTI's policy-making routines. In 1990, the Department introduced a rolling 5-year planning process - known as Forward Looks - through which the internal divisions outline their strategic technology-related intentions and link these to their planned and likely programme actions. The results of programme EVs also feed back to and inform the design of policy portfolios, thus connecting EV with strategic planning. These feedback mechanisms provide early warnings, allow mid-course corrections and enhance policy formulation for new initiatives.

The case below illustrates three major issues, which EV processes external to the policy "implementation structures" face the crucial role that is played by its positioning in the actual activity to be evaluated, the importance of the EV process in the shaping of the effects of EV, and the dual embeddedness (local and global) in the policy landscape.

***(2) The process of evaluation of universities in France - Le Conseil National d'Evaluation**: A national evaluation committee (Comité National d'Evaluation, CNE) was created in 1984 as an answer to the growing debate about university "performance".*

CNE's "oversighting" positioning: It was created as an "independant administrative authority". Independency is guaranteed through a direct reporting to the President of the Republic and no hierarchical connections with the Ministry of Higher Education and Research, as well as through the nomination process of its members: they are nominated for four years and cannot be removed. CNE as an authority has a clearly established mission - the systematic and periodic EV of all the universities - with full responsibility for its EV programme, its methodologies and the dissemination of its products. Finally, CNE as an administration has its own personnel and budget covering all EV costs. This gave CNE the time to learn: after 4 years only a fourth of French universities had been evaluated while they now cover the whole set in the same period of time. This also enabled CNE, by trial and error, to progressively establish its present four stage process.

CNE's process: (1) The preliminary stage deals with information-gathering and is fairly standard. Still, in many cases, this was no simple activity driving to the first recommendation of CNE (the "urgent task to get out of opacity") and to a first managerial effect : CNE has been active in devising what could be qualified as the quantitative dimension of universities' annual report. (2) The next step deals with the terms of reference of the EV, based upon a joint discussion between CNE and the evaluated university. This is an interesting case of institutional learning, since now that CNE has already evaluated all universities at least once, EVs are focused on identified strategic issues mainly linked to previous recommendations and to the objectives of the 4-year plan each university has contracted with the Ministry. (3) The third step is the expertise phase highlighting the three methodological problems faced when using individual expertise. CNE mainly relies on French experts from the universities and is thus faced with a strong problem of independency: experts are evaluating their colleagues, knowing that the situation will soon be reversed. In order to ensure the relevance (competence, reliability) of individual expertises, experts' reports are kept secret and memos have been produced capitalising on previous experiences. To help the production of a common view, exchanges are fostered between experts through joint meetings. But the aggregation remains in the hands of the committee which directly produces an analytical report based upon (confidential) experts' reports. (4) The last step is a contradictory phase. The analytical report serves for an on-site counter-examination with the university government. Taking reactions into account, the conclusions and recommendations are discussed and adopted by CNE and sent to the President of the University for an official re-

sponse. Both make up the official CNE report which is public, printed and widely disseminated.

CNE's dual embeddedness in the French policy landscape: The first and foremost effects for nearly a decade were located within universities, progressively fostering an EV culture where EV is seen as a major resource for self-knowledge and strategy-making. But in many cases, problems were linked to more global issues, which CNE highlighted first in its four-year self-assessment reports and more and more in topic-oriented reports. These have remained near to wishful thinking until the ministry changed its policies and, instead of global processes of allocations to all universities, entered into specific four-year contracting with each university (the so-called "contrats d'établissement"). CNE processes and products were well-adapted to feed the negotiation process between both parties. This points to a crucial aspect in EV performance: EV rarely covers the whole policy, but intermediary "operators" (institutions, programmes, etc.); in addition, connections between both levels are difficult : they do not simply rely upon better, more readable reports, they depend upon the existence of an actual arena where both "local" and "global" actors enter into a negotiation process.

The context of EV processes influences their impact and use. There are many conditions which enhance or provide obstacles to the use of EV data in policy processes. Such factors include relevance, timeliness and credibility of the EV. Also, as the following example shows, one of the conditions which enhance the use of EV data is the circulation and support of ideas about potential changes in the R&D system already before the EV.

(3) Example of use of evaluation; the evaluation of the Academy of Finland in 1992*: The Academy of Finland, a research council organisation, started evaluating fields of research in the early 80s. The quality of research was the major EV criterion and the main method used were panels of external experts. So far the Academy has commissioned 25 EVs of research fields, institutions and research programmes. In 1992, the Academy was itself subject to EV. At the time, after the first wave of EVs in Finland, which concerned research carried out in research fields and research programmes, research institutes and research funding agencies were subject to EV.*

The EV of the Academy of Finland was aimed at evaluating the suitability of its organisation for its tasks and the extent to which it had fulfilled its mission. Before the EV, there had been an attempt to achieve organisational change, which, however, had failed. This was an important background reason for starting the EV. According to the initiative, which had failed, the seven Research Councils were to be merged into three in the hope of increasing the effectiveness of the Research Councils and in response to man-

agement problems with an increasing number of research projects in interdisciplinary areas. The initiative had been blocked in Parliament for reasons irrelevant to the major initiative. After the 1991 Parliamentary elections, the organisational reform was given a new impetus by the Ministry of Education which commissioned a group of foreign experts to carry out an EV of the Academy of Finland. The EV was completed in 1992.

The EV group interviewed a large number of people actively involved in research policy in Finland including members of the research councils and their staff. In their report, the group of experts made a lot of recommendations concerning the daily functions of the Academy. With regard to the organisational reform, the EV group came to a conclusion similar to that of the original reform initiative. Many of the minor recommendations of the EV were taken into account in the daily activities of the Academy, for example, increasing the size of the minimum grant. The major recommendation concerning the number of Research Councils also led to organisational reform. The number of the Research Councils was reduced, but after successful lobbying by the medical scientists, who managed to retain their own Research Council, the number of the Research Councils was eventually reduced to four.

Why did the experts come to the same conclusion as those advocating the organisational reform? Obviously, they were largely dependent on the information provided by the major players in science policy, who were, by and large, in favour of the reform. Another factor is that merging separate Research Councils into one large Council or into a smaller number of larger units was a trend in the 90s – at least in the Nordic countries, which have a tradition of following each other's examples. The EV led to expected consequences because the major players were mobilised in favour of organisational reform already before the EV, and the latter was used as an argument to convince potential opposition.

In Germany, an EV procedure has been established in clinical research centres to facilitate mediation between competing interests of various players in a national S&T system, as follows:

(4) Evaluation as policy learning process: clinical research centres in Germany. *The conditions for clinical research at German university hospitals are regarded as unfavourable and underdeveloped, in an international comparison. By promoting interdisciplinary clinical research centres (ICRCs), the Federal Ministry for Education, Science, Research and Technology (BMBF) wants to provide a lasting impetus to improve the situation. Within the framework of a competition, eight universities were selected which established pilot ICRCs in 1995/96. The federal funding is guaranteed for a certain time span (probably eight years), as a decreasing kick-off financing; the*

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

The concept of the ICRCs grants the promoted faculties and university hospitals a large degree of freedom in organisation and decisionmaking, but combines this at the same time with demanding requirements, not only of scientific performance, but also of the development of innovative and effective management structures for clinical research.

All stakeholders in the arena of clinical research (and the evaluators) are challenged by the fact that the majority of German medical university faculties are conservative and hierarchically structured institutions that do not have much experience - to a great extent are not even interested - in modern interdisciplinary (i.e. clinical) research. At the same time these faculties enjoy a high degree of autonomy. Therefore, the new ICRCs have to develop in a rather hostile environment. The monitoring EV process is supposed to provide, from an outsider's perspective, "objective" information on hampering and fostering factors for the ICRC's development. The evaluators are expected to debate this information with the ICRCs, to feed the learned results repeatedly into the "negotiating arena" of competing and contentious actors, thus finally helping the ICRCs to survive and to develop.

This diagnosis was the intellectual starting point of an encompassing EV effort[31]. *In 1995/6, a multi-annual monitoring EV was started, designed as a continuous learning and "mediation" process between ICRCs, the funding authorities (BMBF, regional science ministries), and the independent evaluators. In particular, the EV project has (1) to analyse the actual development of the ICRCs in relation to the programme's targets, (2) to compare the achievements of the centres against the background of their specific local (clinical, scientific, infra-structural, financial, regulative) conditions, and (3) to put forward recommendations for the future development of ICRCs. In parallel, the EV team is supposed (4) to ensure an open dialogue with the centres in order to ease the empirical analysis and to feed back the analytical results into the ICRCs, (5) to actively support a working group of the ICRCs' speakers and other leading representatives through information inputs, in order to raise the quality and the problem orientation of the debates, and (6) to*

31 For details see Kuhlmann, S. (1998): Moderation of Policy-making? Science and Technology Policy Evaluation beyond Impact Measurement: the Case of Germany, in: Evaluation, Vol. 4, No. 2, p. 130-148

present and discuss intermediate and final EV results regularly with all participating actors.

Intermediary results of the (still ongoing) EV did already trigger off intense debates within the ICRCs and in their environment (faculties, university hospitals). This effect - an intense debate between the partly contentious, partly co-operating actors on the appropriateness of structural modernisation targets and the ways to realise them - is one of the main aims of the policy programme and of the accompanying EV.

The EU has a fairly long tradition in EV of its RTD programmes.

(5) Monitoring and Evaluation of the European Union RTD Programmes: *Since the end of the 70s the European Union stakeholders (the Commission, the Council and the Parliament) have shown significant interest in EV. Even before the enactment of the First R&D Framework Programme, the Commission - following an early request from the Council - approved a "Communication from the Commission to the Council on a Community Plan of Action to the EV of Community R&D Programmes" (COM 83). Since then, EV has developed in co-evolution with RTD Framework Programmes. In the 80s and beginning of the 90s, the European Commission has played a relevant role in the promotion and support of capabilities for S&T EV: methodological developments and case studies were sponsored by the EC.*

EV of RTD activities is established in general terms in the Treaties of the European Union (Article 130p refers to the obligation of the EC to report annually to the EP and CM) and prescribed by the joint decision of the Council and the Parliament for the R&D Framework Programme and the specific programmes which constitute them. The Fourth RTD Framework Programme (1994-1998) established a new scheme for EV, simultaneously the institutionalisation of the practice of EV of RTD programmes, consolidating an EV unit in DG XII and allocating it to DG XII AP in charge of the Framework Programme.

However, the momentum for RTD Programme EV has not been isolated from the general initiatives of the European Commission. In 1994-95 the EC invited a group of experts to review the existing Commission EV activities and to recommend improvements. Following this report, and within the general framework of what is called the "SEM 2000" initiative (Sound and Efficient Management), an internal communication on EV was issued entitled "Evaluation: Concrete steps toward best practice across the Commission". This general trend has a strong financial management content because "the results of EV of Community actions, undertaken periodically, should be taken into account in decisions concerning budgetary allocations".

After the document "Towards implementation of coherent monitoring and EV of Community RTD actions" issued by CREST (1208/95, 19 May 1995) and the SEM 2000 initiative, the Commission produced a communication on "External and independent monitoring and EV of the Community activities on the domain of RTD" (COM(96)220 final), which defines the standard practice for EU RTD programme EV[32]*. The EU proposal for monitoring and EV of programmes would be accomplished through two type of actions referred to the FP and specific programmes: (1) continuous monitoring with the help of external independent experts and preparation of an annual report ; and (2) five year mid-term assessment, done by external independent experts, including the conclusions of the final EV reports of the previous FP and specific programmes. The "five-year assessment" report of the FP and its specific programmes, in addition to the comments of the Commission should be sent to the European Parliament, the Council of Ministers and European Science Council before the presentation of the proposition for the new FP. Aspects included in these reports are: coherence between the selection of projects, the objectives of the programme; efficiency of the management of the programme; etc.*

These "official" EVs of RTD Framework and specific programmes involve primarily the setting up of "panels" of independent external experts. The request of "independent" evaluators may be viewed as a way of increasing credibility; it involves a variety of actors and pays regard to the complexity of the decisionmaking process. In practice, S&T programme EVs are organised with low budgets and they do not involve many people (usually 3 experts for monitoring panels or 5 experts for mid-term five-year assessments) who are increasingly dependent on the provision of information and support by the EC. In addition, the independent evaluators are selected directly by the programme management unit.

The overall approach to EV is very much linked to the programme management and implementation assessment, that is an acceptable solution which provides information for both, the agent (EU) and its principal (Council of Ministers). No obligation appears to be referred in relation to the "impacts or socio-economics effects of the S&T programmes"; however, these activities are not forbidden, they become dependent on the entrepreneurial initiatives of the Directorates[33]*. Although "official" monitoring and EV panels play a role*

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32 See Fayl, G. /Dumont, Y. / Durieux, L. /Karatzas, I./ O'Sullivan, L. (1997): Evaluation of research and technological development programmes: sa tool for policy design. In: Research Evaluation, vol. 7, no. 2, 93-97

33 For the 5th Framework Programme a more ambitious concept for the assessment of socio-economic impacts has been suggested. See Airaghi, A. /Busch, N. /Georghiou, L. /Kuhlmann, S. /Ledoux, J.M /van Raan, A. /Viana Baptista, J. (1999): Options and Limits for Assessing the Socio-Economic Impact of European RTD Programmes. Report to the European Commission. See also Guy, K. /Clark, J. /Balázs, K. /Stroyan, J. /Arnold, E. (1998), Strategic Options for the

in assessing the functioning of the RTD Programmes and provide official information for the stakeholders' positioning, the EU continues to commission other EV exercises - carried out by EV experts - on relevant issues for assessing S&T policy.

Conclusions

(1) The European "evaluation culture", meanwhile, has a broad range of *conceptual and methodological experiences* at its disposal. Methods of various types have been developed and utilised to determine attained or attainable effects; the most important are[34]: (peer reviews, before/after comparisons, control or comparison group approaches, a variety of quantitative and qualitative analyses etc.). These conceptions can be carried out individually or in combination with various data and indicators (financial expenditure on research and development, patents, economic, social, technical indicators, publications, citations, etc.), data collection methods (existing statistics, questionnaires, interviews, case studies, panels, etc.), data analysis methods (econometric models, cost/benefit analyses, other statistical methods, technometrics, bibliometrics, peer reviews, etc.[35]). All the procedures have different strengths and weaknesses, which makes using a combination of methods advisable.

At the present stage of evaluation research, and despite all the (necessary) efforts made to objectify the methods and the resulting indicators, we must *warn against considering quantitative indicators alone to be adequate for evaluation purposes*. The understandable desire for a tool-box of indicators which can be used in a standardised fashion is not realisable at the present stage of development of evaluation methods, and in particular, of our knowledge of the dynamics of innovation processes: a measurable research performance and related output do not automatically produce socio-economically effective innovations.

(2) Experience proves that any EV is faced with *challenges*, some related to the methods development, others to budgetary and time limitations. In *impact assess-*

Evaluation of the R&D Programmes of the European Union. Report to the Scientific and Technological Options (STOA) programme of the European Parliament, Brighton (Technopolis)

[34] See e.g. Meyer-Krahmer, F. / Montigny, P. (1989): Evaluations of innovation programmes in selected European countries. In: Research Policy, 18, vol. 6, 313-331; Bozeman, B. / Melkers, J. (eds.) (1993): Evaluating R&D Impacts: Methods and Practice, Boston et al (Kluwer Acadamic Publishers); Callon M. / P. Laredo / Mustar, P. (1997): The Strategic Management of Research and Technology, Paris (Economica International); Shapira, P. /Youtie, Y. (1998): Evaluation Industrial Modernization: Methods, Results, and Insights from the Georgia Manufacturing Extension Alliance. In: The Journal of Technology Transfer, vol. 23, No. 1, 17-27.

[35] For related technology indicators see Grupp, H. / Kuntze, U. / Schmoch, U. (1995): New Technology Indicators for the Evaluation of Research and Development Programmes. In: Becher, G. / Kuhlmann, S. (eds.): Evaluation of Technology Policy Programmes in Germany, Boston et al. (Kluwer Academic Publishers), 243-284.

ment, EV is faced with the fact that it takes many years for impact to be seen; however, those commissioning the EV seldom wish to wait for years to find out about impact. Further, those involved in the processes might have difficulties in remembering the events concerned if consulted much later. There are other methodological challenges. *Attributing effects* to the initiatives to be evaluated is a basic difficulty faced by all EV exercises. Further, indirect effects are not sufficiently taken into account because of the difficulty in measuring them. Lastly, socio-economic effects and contribution to societal needs are difficult and laborious to evaluate. There is a need for new developments in methods to help such EV exercises.

(3) There have been many changes and developments in the theory and practice of EV over the past decade or so. In particular, in countries where EV has taken root fairly early, following *trends* can be observed:

0 The major rationale for EVs has shifted and evolved from a desire to *legitimate past actions* and demonstrate accountability, to the need to improve understanding and *inform future actions.*

1 Correspondingly, the issue focus of EVs has broadened away from a narrow focus on quality, economy, efficiency and effectiveness, and towards a more all *encompassing concern* with additional issues, such as the appropriateness of past actions and a concern with performance improvement and strategy development.

2 Approaches to EV have evolved away from a purist model of "objective neutrality", characterised by independent evaluators producing EV outputs containing evidence and argument, but no recommendations; to more formative approaches in which evaluators act as process consultants in learning exercises *involving all relevant stakeholders*, providing advice and recommendations as well as independent analysis.

3 This has led to more *flexible and experimental approaches* to the construction of policy portfolios, and to even greater demands for well specified systems of monitoring, EV and benchmarking to aid analyses and feed into strategy development.

Many EVs thus reflect an increasing concern with the link between EV and strategy, with an eclectic mix of methodologies used within the context of individual exercises to satisfy the demands for understanding and advice. Increasing attention is also being paid within many institutional settings to the way in which EVs can inform strategy.

(4) EV of the societal impact could be improved by adopting some of the processes currently used in TA where citizens are engaged in the assessment of the societal impact of various technologies.

2.3 Technology Assessment

Technology assessment (TA), with its twin components of anticipation (of effects and impacts) and evaluation and feedback into decisionmaking, is done in various ways, depending on the key actors and the arenas. Three strands, each with its own style, can be distinguished:

- A in firms and in technological institutes, oriented towards mapping future technological developments and their value to the firm or institute, and used as an input in strategy development. *"Picking the winners" (or "avoiding the losers")* used to be the overriding orientation. This strand of TA has developed relatively independently of "public domain" TA, but links are emerging because of the need of firms to take possible societal impacts and public acceptance into account; biotechnology is the main example at the moment (cf. also box on Constructive TA).
- TA for policy development and political decisionmaking about projects or broad programmes with a strong technological component (think of the electronic superhighway or modern agriculture) or important technologies (like genetic modification). One can call this *"public service" TA*, and consider the USA Office of Technology Assessment (OTA) as the embodiment of this type of TA. OTA has, during its lifetime, developed a robust approach to TA studies, which can still be followed profitably. Other TA bodies serving national parliaments and/or national governments were modelled on the OTA example, but have to attend to their specific situation and tend to include participatory TA methods in addition to expert- and stakeholder-based approaches.
- *Agenda-building TA* is the most recent strand. While it is particularly visible and more or less institutionalised in some European countries (Denmark, the Netherlands), participatory methods like consensus conferences are taken up all over the world. *De facto* agenda-building TA has a longer history; for example, controversies over new projects or new technologies (and the studies and documents produced in the course of the controversy) induce learning (about potential impacts) and articulation (of the value of the technology). Agenda-building TA merges into informed consultation processes to reach agreement on the value of new technology, as happens for instance through *Sozialpartnerschaft* in Austria.

The contrast between private domain TA and public domain TA seems strong, because of the difference in goals and in actors involved. The scope of *private-domain TA* is less broad than in public-domain TA, but the assessments try to be more precise and their outcomes are fed back into strategy development and decisionmaking. More recently, there is interest in involving public-domain TA experts in early stages of the firm's innovation process, when uncertainties about the nature of the product and its impacts are still high. In the approach of Constructive TA, private actors are encouraged (and provided with relevant tools) to broaden the scope of their assessment process, already at an early stage of new product or process development.

***(1) Constructive TA*[36]**
The idea of introducing TA activities at an early stage in technology development, and thus broadening the aspects and the actors being taken into account, was introduced in the Dutch Policy Memorandum on the Integration of Science and Technology in Society of 1984. It has been articulated further by mobilising insights from sociology and economics of technology – sometimes summarised as "social shaping of technology", as in the European COST A4 Action. Constructive TA is not simply a management tool. At the micro-level, it helps to create broader design practices. Demonstrators and societal experiments (at the meso-level) are occasions for societal learning about new technologies and (hopefully) feedback into further development and uptake. At the macro-level, Constructive TA attempts to bridge the gap between promotion and control of technology, which appears to be a feature of modern societies: different government ministries are responsible for promotion and control (e.g. Departments of Trade and Industry versus Departments of Environment, and Public Health) and critical and promotional groups around new technologies contribute to societal agenda-building through contesting each other. While still programmatic in parts, Constructive TA has also developed generic strategies like Strategic Niche Management, and mapping tools to anticipate the embedding of new technology in society.

In *"public-domain" TA*, the difference between "service" TA, with its emphasis on reports, and "agenda-building" TA, with its emphasis on interaction, is a gradual one. It is not always clear who should implement the "agenda" built through TA; it is a diffuse, societal agenda on which various actors can draw. In general, the direct impact of "public-domain" TA on science and technology policy and decisionmaking need not be large. When there are controversial issues, there is more immediate interest in TA. There are a few examples where the performance of a TA study or exercise is required by law or by arrangements for advice (see also the box on the French Law on nuclear waste, below).

What is shared in all three strands, and can be considered characteristic for TA, is the dedicated effort at anticipation of effects and impacts of technologies and technological projects. This is motivated by a TA "philosophy": traditional trial-and-error learning how to handle new technologies in society brings unnecessary human

[36] See further A. Rip, Th. Misa, J.W. Schot (eds.), *Managing Technology in Society. The Approach of Constructive Technology Assessment* (London: Pinter Publishers, 1995), and Johan Schot and Arie Rip, 'The Past and Future of Constructive Technology Assessment,' *Technological Forecasting and Social Change*, 54 (1997) 251-268.

and ecological costs with it, and one should try to do better by anticipating potential impacts and feeding such insights back into decisionmaking and strategies of the actors involved. While the three strands distinguished above fit this broad description, it also allows one to recognise a TA component in other activities, for example in early warnings. Historically, the interest in an "early-warning" system was one reason why a TA office was proposed in the USA in 1966 (by Senator Daddario); the other reason was the need of Congress for policy-analysis support of its own.

The broad description of TA as a *variety of methods and approaches* to make the TA "philosophy" operational helps to understand the relevance of the wide range of actual TA activities, from specific impact assessment methods (which merge into environmental and social impact assessment) to scenario-type anticipations which stimulate public debate. TA can then be linked to democratic culture (which would explain the high level of TA activities in North-West Europe compared with the lower level in young democracies like Spain), and to science and technology policymaking, especially when there is interest in broader priority setting which includes evolving demand and embedding in society.

The broad description also highlights a fundamental dilemma, which has been called the *anticipation & control dilemma*[37]. At an early stage of technology development, the nature of the technology (and the articulation of interests) are still malleable – but it is unclear what the effects and impacts will be. By the time these become clear, the technology is entrenched and vested interests make it difficult to change the technology. As with the pesticide DDT, it becomes a matter of forbidding further deployment of the technology.

Recent economics and sociology of technology have traced the *increasing path-dependencies* in technological development, and the co-production of impacts that occurs at the same time. The QWERT keyboard of typewriters, but now also of computers, is a well-known example. From the point of view of the TA "philosophy" (rather than the specific methods of impact assessment), a generic TA strategy would be to maintain some flexibility, or at least avoid irreversible path dependencies. The French Law on nuclear waste handling actually embodies such a principle (see box 2).

In this sense, technology assessment is much more an advisory than a scientific research and policy-analytical activity. Increasingly, the *advisory activity includes participation*, and thus becomes joint agenda-building. One can compare this shift with the recognition, in foresight and evaluation exercises, of the importance and effects of the process as such, rather than just the data collection and analysis.

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37 Collingridge, D. (1980): *The Social Control of Technology*, London: Frances Pinter.

(2)The French law on nuclear waste handling: *As in many other industrial countries, the increasing deployment of nuclear power raised the issue of nuclear waste. The French government opted for deep geological confinement, and used expert advice and established, in 1979, an institute for underground research ANDRA. When sites had to be chosen in the late 1980s, strong local opposition emerged. So far, the story is what happened everywhere. By 1990, however, the government changed tack: it decided on a one year moratorium, and asked Parliament, specifically its TA office, Office d'évaluation des choix scientifiques et technologiques, for a full review.*

The office, created in 1984, is common to both chambers and, contrary to the US OTA, gives direct responsibility to parliamentary members for conducting projects. Sénateur Bataille adopted the US approach of public hearings of all types of stakeholders. The Bataille Report (1990) emphasized that it was too early to choose one solution only. Other technical solutions (transmutation and surface storage) should be explored as well, a development period of 15 years was necessary to give each option similar chances. And to make sure this would actually be done, it proposed a specific law -- a radically new political process for handling TA!

While the government accepted the idea of a law, it tried to avoid any binding mechanism. In the end, the 1991 Law had strong provisions; in particular, it included a regular TA effort.

- *The15 year transitory period during which no irreversible decisions are to be taken*
- *The competition between the three options is organised by having different institutions responsible for each of them.*
- *There will be an annual public review of all research programmes, to be done by a national evaluation commission under the auspices of the Office parlementaire des choix scientifiques et technologiques.*
- *On each site where experiments are undertaken there will be a "local commission for information and concertation" so that all stakeholders can follow and debate the work-in-progress.*

What is fascinating here is how the overall philosophy of TA is given concrete form in a structured and authoritative process. How did it work out? The Commission nationale d'évaluation has been influential enough to forbid any financial cut-down on one of the options (as was envisaged by the government at one time). For the experimental sites, selected in 1993 after a broad review, local commissions were created which were able to emphasize criteria for choice like reversibility. The Commission nationale d'évaluation argued that the traditional public enquiries for the sites (compulsory for the development of all new infrastructures) conducted in 1997 and which were all positive, were too limited and taking a broader perspective, proposed that one of the sites which was not suitable should be abandoned.

The strengths and weaknesses of technology assessment cannot be identified unambiguously, because of the variety in the contexts of use, and thus in goals and style. It is clear that *there is renewed interest in TA*, and that this has to do with the increased possibilities of combining private-domain and public-domain TA, and with the role of TA in broader priority setting, technology roadmapping, and articulation of views about new technology. This trend is also visible in the Fifth Framework Programme of the European Union, where the RTD Programmes will have a social-science component, often addressing issues of effects and impacts.

Methods of TA can be technology- and context-specific, which will improve the chances of results being taken up in decisionmaking and actor strategies. Analysis with the help of economics and sociology of technology offers generic insights, as does the other main cluster of methods focussing on consultation and participatory agenda-building.

It has been noted that *technology foresight methods might be used for TA, and vice versa*. There may well be such opportunities, for example the Delphi method. The German study, *Technology at the Threshold of the 21st Century*[38], is a foresight study, but indicates the relevance of extending foresight methods to TA. The experts involved in technology foresight studies are assumed to have some feeling for the effects and impacts of new technology, even if this is often limited to the promise of new technology. In other words, an informal TA competence is required, which could profit from exposure to TA methods and experience. Technology foresight and TA can jointly contribute to (distributed) intelligence about future developments and their value. A difference in style and context will remain: Foresight aims to open up spaces for thinking about new possibilities, TA is oriented to selecting or at least modifying and modulating developments. The link with decisions and strategies implies that there will be more and more broadly based contestation than with foresight, which often remains limited to communities of experts.

2.4 Seeds of Combination

In order to trace potential starting points and already existing practices of an integrated and coherent use of TF, TA and EV, the ASTPP network mapped the diversity of the understandings, connotations, practices and uses of the three intelligence tools across Europe. The main conclusion was that the three forms of intelligence are still far from integrated, in terms of the issues covered, its user groups, purpose, institutional settings, methodologies and its performers. The picture that emerged varied from country to country, partly related to different life cycles in technology

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[38] Grupp, H. (ed.) (1993): Technologie am Beginn des 21. Jahrhunderts, Heidelberg (Physica/Springer).

policy planning in these countries. Section 2.4 describes the state of integration on each of these subjects for the countries we have reviewed.

Nevertheless, as stated in the introductory chapter, the underlying hypothesis of this report is that the existing body of experiences with the enhanced intelligence tools TF, TA and EV provides a basis for the development of an advanced innovation policy "planning" approach. Elements of an integration as a basis of Distributed intelligence (DI) for innovation policy planning may be found in different *national resp. cultural environments* (section 2.4.1), different *institutional* settings (section 2.4.2) and as an effect of cross-border *transfer* of practices (section 2.4.3).

2.4.1 Elements of Integration in the Context of Different National Cultures of Innovation Policymaking

Mapping the current practices in the European countries, produced a varied picture of the degree of interrelation in the practices of the three forms of intelligence. The members of the ASTPP network reviewed the practices in their countries addressing a number of questions:

Are there *interrelated "official" definitions* of TF, TA or science and technology policy EV? Answers to this question could indicate the degree to which integrated practices have already become established. So far, we found *no integrated definition*, not even interrelated definitions, and in several cases not even single definitions for TF, TA or EV.

Are the *issues covered* by TF, TA or EV efforts *deliberately interrelated*? In most countries this is *normally not* the case, although a number of diverse exceptions could be found. In France, where the issues dealt with today are only loosely linked, recent decades saw already a stronger integration. The opposite turned out in Portugal, where recently some at least slightly integrated strategic intelligence approaches where pursued.

Do the *main users* of TF, TA or EV *complement each other* and interact? Obviously, the extent and the quality of user interaction depends on the institutional structure and distribution of tasks between the institutions within the research system. Besides the case of Greece where mainly one single user (the General Secretariat for Research and Technology, GSRT) is a regular client of intelligence tools, in most other countries various users - government agencies, research organisations, industries - *interact to a certain but restricted extent* amongst each other in terms of TF, TA or EV. For France there are hints that user interaction was stronger developed in the past (see below). In the United Kingdom user institutions take advantages in particular from combined TFs and EV information. To a certain extent this seems to be similar also in Spain.

Are the *main purposes* of TF, TA, and EV *interrelated*? In the policymaking context, the main purpose of TF efforts in most countries is to structure the debate of future options in science and technology and related policy choices. The main purpose of TA is to debate the social and environmental acceptance of new technologies. The main purpose of science and technology policy EV is the legitimisation of related policies and the achievement of learning effects. In many countries these purposes so far are *only loosely inter-linked*. In Finland, the purposes followed seem to complement each other to a certain extent (TF: identifying emerging technologies; TA: informing the users; S&T policy EV: assessing effectiveness of funding decisions and related policies). Again, a similar picture is emerging in Portugal. As was stated already for the users' interaction (above), in the United Kingdom (and to a certain extent in Spain) the purposes of TF and science and technology policy EV seem to be complementary. In the Netherlands there is probably a certain overlap and common understanding of the purposes of TF and (constructive) TA.

Is there a *linked institutional setting* for TF, TA and EV in the sense of e.g. formal routines? For most countries one can detect only *loose institutional links*; this is mainly due to the fact that in most cases TF and in many cases TA are not institutionally established while only policy EV is based on an increasingly stable institutional basis. Again, France seems to have seen more strongly inter-linked institutional procedures in previous decades. In Portugal and in Spain institutional routines seem to be matched to a certain extent, at least between TF and EV.

Are the prevailingly *applied methodologies* and the underlying theories of TF, TA and EV efforts *interrelated*? In most countries the scientific communities in the three areas pursue their *work still rather separately* (although the communities overlap; see below). In those countries which experienced recently quite prominent TF efforts and have at the same time a considerably well developed EV and TA practice, one can detect a few attempts of interrelated methodological approaches and some hints that these efforts are still emerging, e.g. in Germany and the United Kingdom.

Are the national *key performers* of TF, TA and EV *linked*? Although - as stated above - methodological linkages are still only emerging, in most countries the (independent) research groups/communities carrying out TF, TA, and EV studies represent the *strongest link* between these three strategic intelligence tools - via personal or at least institutional identity. They represent a "natural" platform for further conceptual and methodological integration.

Are the *resources* available for TF, TA, and EV systematically *matched*? As a consequence of the only loosely inter-linked institutional setting one can detect a matched deployment of resources *only in single cases* across all countries.

The ASTPP network does not insist that the three intelligence tools, TF, TA and EV, should be integrated per se, yet when a combination of skills contributes to the aims of the policy exercise at hand. We have already discussed that the purposes for which the three are used can vary considerably, therefore the consideration how the forms of DI are used should be made on a case by case manner. There are some general suggestions to be made.

In some cases a combination of two forms of intelligence could provide practical and useful insights, in other cases the policy decisionmaking process would benefit from the combination of all three. In general the broader the potential socio-economic impact of an emerging technology, the stronger is the case for using the full array of available techniques for strategic intelligence.

The following matrix (*Figure 2.1*) lists in what way a combination of skills could improve the decisionmaking process by using a combination of TF, TA or EV exercises. From a distillation of current practices and experiences with the three forms of intelligence, the matrix shows how the three approaches could serve as an input in the policymaking decision process in a more integrated manner. In the column on the left hand side are the main exercises as they are performed separately at this moment. On the top row are the inputs that could be included from the other two forms of intelligence. In general terms TF exercises can help EVs and TA, to take into account future technological developments, which could alter the strategic perspectives of current S&T activities. TA can contribute by pointing towards the needs and interests of a wider group of stakeholders, than is usually involved in the EVs and TF studies. In addition, the experiences with guiding the social processes of articulating needs could be used in the other two forms of intelligence. Evaluation methodologies can improve the other two exercises. Perhaps even more important, the close links between the EV performers and the policy clients can improve the actual use of the results from TF and TA exercises.

Figure 2.1 Combinations of the EV, TF and TA to enhance S&T decision-making processes

Input from: Main exercise:	**Evaluation**	**Technology Foresight**	**Technology Assessment**
Evaluation		• benchmarking to identify potential S&T developments • increase strategic dimension ex-ante EV • contribute to appropriateness issues • set the right context for EVs	• knowledge on processes to assess externalities and effects on a wider set of stakeholders • make value issues more explicit (biotechnology) in EV
Technology Foresight	• benchmarking present capabilities with future developments for SWOT analysis • EV of TF exercises to improve future use of TF • Bring TF closer to policy clients		• increase awareness of social issues in prospective outlooks • anticipating social barriers • articulation of public values • avoid tunnel vision (widen the technological context)
Technology Assessment	• expose problems in S&T programme due the lack of TA at start • EV methodologies (as process and techniques causalities) can improve the TA analysis on effects	• widen the technological context (avoid tunnel vision) • increase future outlook • expose strengths and weaknesses S&T infrastructure • expose user needs of various stakeholders	

2.4.2 Examples of the Potential for Integration in Various Institutional Contexts

Despite the variation in the use and integration of EV, TF and TA in the European countries cases can be found which illustrate *seeds of combination*. These include an integration:

- in terms of *user communities*: stakeholders with different positions in the innovation system could learn to inter-link with each other better, using the tools of one or more the three approaches. Similarly, the traditional performers of EV, TF and TA could benefit by learning to adopt each other's approaches.

- in terms of *methodologies* used simultaneously: the traditional clients of the three approaches, i.e. innovation policymakers are usually familiar with only one of the approaches. A better understanding of the merits and pitfalls of the other two forms of intelligence and of the benefits of combined use are vital first steps for the emergence of an integrated Distributed Intelligence System.
- in terms of *performers* of the exercises: the key performers of the exercises have a role to play in order to disseminate the understanding and experimentation with the combined use of the three forms of intelligence.

The following cases illustrate these seeds of combination. The first is the case of ADEME where in the course of time, a new approach in EV and TF practices developed by EV experts, was taken up by research practitioners and developed into a strategic planning tool for future research implementation. The second case describes how in Germany Delphi results were used to evaluate a research organisation. The third case describes an example how industry has used the three simultaneously to assess a technological opportunity which had a wide range of potential commercial possibilities.

(1) Evaluation and foresight at ADEME, the French environment and energy agency: a sustained collaboration between practitioners and researchers: ***The French environment and energy agency ADEME was established in 1992 as a merger of three former agencies: for waste management (ANRED), for air pollution (AQA) and for (non-nuclear) energy (AFME). ADEME's mission is broad. It reaches from the support of research (e.g. through a PhD scheme), to demonstration, education and local development projects, in all areas relating to environment and energy (except those related to water), and in virtually all economic sectors. ADEME is managed by three ministries i.e. environment, research and industry. It receives funding directly from these ministries and through special levies and taxes, for instance on landfill.***

ADEME does not conduct research itself, it supports other organisations to do so. Already in the mid-1980s with its predecessor AFME, this led to the problem how to legitimise the agency's activities, towards the public authorities. Since research does not immediately lead to tangible or measurable results, ways had to be found to account for the activities of ADEME, and to evaluate whether these were satisfactory.

Therefore, in the second half of the 1980s a collaboration was established with the Centre de Sociologie de l'Innovation (CSI). Together with AFME, CSI developed the approach of techno-economic networks to manage and evaluate the technological research programmes. The approach was based *upon the formalisation of the action of ADEME's programme managers. It describes the agency's field of intervention in terms of actors and intermediaries, around three main poles (Science, Technology and Market) and two "transfer" poles (ST, TM). Hence the agency gave itself the task to stimulate the emergence and development of networks around energy technologies, and promote the interaction and exchange between users, developers, engineers and scientists in such networks. The EV of programmes became the EV of the agency's capability to co-construct networks.*

The methods and concepts were taken over by the new agency in 1992. A new situation occurred: the agency moved into environmental technologies. However, the advice of outside specialists was no longer needed: the agency had made itself so familiar with the method that it easily extended it to include a new pole (Regulation) and corresponding transfer poles. The use of EV and its tools has become routine business for the agency. EV practice has been extended to other areas than those strictly linked to R&D. Also, the network approach has been adapted for use within strategy formulation.

Finally, other research organisations in France have started to adopt the techniques for their own strategy formulation.

Many lessons can be learned from this experience, but in this context one seems particularly interesting. It concerns the interplay between research policy practitioners and social scientists, and the subsequent integration of the tools in the daily practice of policymaking[39]. The tools developed have a strong theoretical basis (from innovation studies), but they have been continuously tested on real life situations, proposed to ADEME's people, nourished by new theoretical insights, transformed to account for new problems the agency is faced with. This continuous interaction between various actors - and not a linear development whereby the policy advisors develop tools and policymakers subsequently adopt them - may explain that, after more than ten years, the approach is fully absorbed by the agency. In fact, it has become nearly tacit knowledge in the daily practice of ADEME's collaborators. Today it serves as a general but nevertheless practical heuristic tool, no longer only for EV per se, but, far more broadly, to organise and evaluate the agency's action internally. It also helps to organise the dialogue with the relevant ministries, the beneficiaries of the agency's support and other parties involved in this field of policy.

39 Laat, B. de (1996): Scripts for the future. Technology foresight, strategic evaluation and socio-technical networks: the confrontation of script-based scenarios, Amsterdam (PhD thesis)

(2) Using Delphi results for the evaluation of a research organisation: the Fraunhofer-Gesellschaft. *Background: In 1996, the German Chancellor and the "Ministerpräsidenten der Länder" decided to evaluate all research institutions which are jointly financed by Bund und Länder (Fraunhofer-Gesellschaft (FhG), Max-Planck-Gesellschaft, Deutsche Forschungsgemeinschaft). Main aim of the EV of these organisations is not a detailed analysis of research performance of their units, but the assessment of the function of these organisations in the context of the German "research landscape". Commissions were built up in order to conduct these EVs.*

Specific evaluation task: The FhG is a semi-public contract research organisation consisting of 49 quite autonomous institutes primarily active in the field of applied technological research. One of the most important issues of the FhG evaluation was: Which technology-related markets promise (world-wide and national) the largest growth? Is the FhG sufficiently represented in these markets? Does the technological portfolio of the FhG fit with related technological developments world-wide?

Working Steps: To facilitate answers to the above questions, the commission decided to use the results of the "Delphi '98"[40] *Study. For 1019 out of 1070 theses of the study, an internal group of Fraunhofer employees made a rating of FhG-competencies*[41]*. For this purpose, an index was constructed consisting of three criteria which were considered to be important for the FhG: (1) Necessity of an improvement of the research infrastructure, (2) time horizon of realisation of a technological solution, (3) importance for the economic development. Within 11 out of 12 sub-fields of the Delphi Study (for example, Information and Communication Technologies), the theses were sorted according to this index. Hereby one gained a set of figures of "important theses" on the one hand and the FhG related competencies on the other. The Commission received these figures as a crucial input to the assessment of the adequacy of the given FhG portfolio.*

Lessons to be learned: Using TF Results in order to evaluate a research institution enables evaluators to get a broad impression of the fit between world-wide developments and the portfolio of a research organisations. It is possible – constructing an adequate index – to use the Delphi study also for other research organisations.

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40 Cuhls, K. / Blind, K. et al. (1998): DELPHI '98 Umfrage. Studie zur globalen Entwicklung von Wissenschaft und Technik. Edited by the Fraunhofer Institute for Systems and Innovation Research on behalf of the Federal Ministry for Education and Research (BMBF). Karlsruhe (ISI)

41 Five groups of competencies were differed: concrete projects in at least two institutes, concrete projects in at least one institute, significant research competencies in at least one (or two) institute, no concrete projects or siginificant competencies in this field.

***(3) Foresight, TA and EV - industrial synergies**: In the early 1960s the association between asbestos and asbestosis (lung cancer) was growing. The medical evidence was contested by the industry, as the precise identification of the form of asbestos that caused mesothelomia was not immediately obvious. At that time asbestos was a valuable material, notably for its fire resistance and for its ability to reinforce cementitious materials, though they remained brittle. It was foreseen in the early 1960s that these difficulties for asbestos could lead to disastrous lawsuits, particularly in the USA, and could open business opportunities, especially for new cementitious materials. It was natural to make an analogy with glass-reinforced plastic, but the initial experiments carried out in Russia were a failure as the aggressive nature of alkaline setting Portland cement was not appreciated. The glass fibre used in these experiments was rapidly degraded, causing the reinforcement to disappear, leaving a very fragile cement matrix. Prospective technical analysis indicated the possibility of overcoming this difficulty and this was successfully demonstrated by the UK's Building Research Establishment (BRE) from 1968 onwards and patents were secured. For commercial exploitation an industrial partner was essential and at this juncture the National Research & Development Corporation (NRDC) and Pilkington PLC came together to form a collaborative venture in which initially Pilkington would assume responsibility for developing the glass fibre optimisation and production. Pilkington secured appropriate rights to the use of BRE's patents and later assumed responsibility for the commercial development of glass reinforced cement (GRC) technology and its exploitation.*

At the earliest time in the commercial exploitation a scenario-planning exercise was undertaken to set the business possibilities in their widest possible context; this required synergy between considerable TF, prospective TA (PTA) and prospective EV of the business. These three streams of thought were integrated to create a series of scenarios for the business over a 20 year time horizon. Broadly, the synergy was brought about by marrying together qualitative and quantitative methods via systems modelling. TF focused on the future of the business in the wider context encompassed under a mode of thought STEEPV[42]. Technical developments were planned within the opportunities and constraints revealed from this wider context, to meet the foreseen markets, regulations governing use and to secure future competitiveness of the material, which had the unique property of quasi-ductility in a cementitious material. All of the foregoing were evaluated prospectively via a computable model; this was, of course, partial as many qualitative assumptions

42 Oliver, D. / Loveridge, D. / Holroyd, P. (1984): A Decade of Business Prospecting: 1971-1981 at Pilkington's. In: Futures, June 1984, 286-301.

had to be made on the basis of the wider systems modelling. The integration was complete, and allowed the construction of scenarios that were both qualitative and quantitative; these were used to direct the development of the business, up to the time six years later when the business became part of a larger existing operating division in the company.

Periodic revisions were made to the scenarios as continuing TF activity revealed new possibilities both favourable and unfavourable. In addition, periodic major reviews were conducted by the company's Main Board to see that milestones were being met; this would be recognisable as real time EV in modern parlance and periodically took the form of a full-scale business audit comprising hearings in front of a Main Board appointed Audit Team, along with written evidence. Post-event EV that fitted into much wider company planning occurred much later when it was decided to dispose of the business due to a reorientation of the company's business directions.

2.4.3 Linkages across Geographical Borders

Another form of seeds of combination concerns the dissemination of the EV, TF and TA cultures across geographical borders. With the integration of the European Communities also comes a closer integration of both policymakers and performers of the three forms of intelligence. The European Commission has played an important role in the encouragement of more cross-border fertilisation of good practice in innovation policy in general and the use of policyplanning tools in particular. For S&T policy EV, the European Commission has, in the past, proved itself more willing than most national governments to apply experimental methodological approaches. Helpful studies were initiated in the 1980s (e.g. within the MONITOR /SPEAR programme), that created new competencies and linkages. But since the 4th Framework Programme, the Commission has drawn back, and the experimental thrust wasted away. The new guidelines for EU S&T evaluation procedures put forward by CREST (1208195) and generally based on a peer review panel-based approach, delivers a certain quality control, but no strategic information and no link to TF or TA results and insights (see also section 2.2).

More EU actors have contributed to disseminating better policyplanning tools. The case of the Regional Technology Plans presented below is an example of the European Commission aiming to improve the innovation policy process of regional authorities. Multilateral examples of exchange of ideas and practices of innovation policy EV are illustrated by the collaboration between the Nordic countries.

(1) Regional Technology Plans as inter-cultural exchange of policy planning: *In 1993 the European Commission DG XVI (Regional Policy and Co-*

hesion) launched a pilot initiative called Regional Technology Plans which was to initiate the development of a Regional Policy Strategy for Research, Technology and Development. The projects in this initiative were to be undertaken in so-called "less favoured regions" which had an Objective 1 and 2 status. European Commission officials who set up this initiative had perceived a lack of policyplanning culture with many regional governments. Particularly in the area of science and technology, no experience had been developed, since this area had traditionally been the domain of national policymakers. Particular concern related to the top-down approach in regional technology policy initiatives either from centralist national authorities or inexperienced regional authorities.

What the Commission offered was a policyplanning model which included both an indication of the contents and a structure for the 18 months long RTP policy process. In terms of contents the RTP prescribed a "demand driven" analysis phase during which the "real" innovation issues in industry were investigated as a basis for policy action. In terms of process the Commission propagated a "consensus-based" approach, where government agencies were to involve a large group of stakeholders to discuss strengths and weaknesses of regional innovation system, define priorities, and set out (pilot) projects. Many public-private partnerships were established as result of the RTP projects. Seven regions entered the experimental action and went through what was to become an ongoing S&T policyplanning process. The Commission played a "mentor role" in the background, the regions themselves were responsible for running the RTP projects.

One of these regions was Limburg in the Netherlands. Prior to the RTP, RTD policy did not have high priorityin the Province and was dealt with as a side line of mainstream economic policy. There was no explicit strategy and subsidies went haphazardly to the main innovation support agencies who put forward project proposals. The RTP set into motion a policyplanning process which involved people from industry, intermediaries, research centres, the regional development agency and the provincial government. The aim was to generate a broad base of support among all those involved in developing an innovation strategy. Outside experts were involved to conduct analyses. After this process, which took two years, the Province had a policy strategy for Limburg, consisting of ten priority areas and a number of pilot projects. It also put in place an agreed "support selection mechanism" which assessed whether new programmes and projects fit the issues set by the RTP. But most of all it helped create a more open policy "culture" where policymakers involve stakeholders in discussing and defining demand-oriented policies, through discussion platforms, steering committees, seminars, company visits and so on. Another result was that being part of an international network of RTP regions, exchange of experiences with other regions resulted in longer term international collaborations. The EV of the RTP Initiative showed that *the general policyplanning model, first defined by the Commission and adapted over the years, can work in very different settings, as long as the regions themselves have sufficient freedom to adapt contents and process to local conditions. It also showed that the required EV systems which were required by the Commission were hardly put into place. Difficulties in deciding what tools and methodologies to apply, and finding the resources to operate them were the main reasons. The RTP Initiative is now continued under the name Regional Innovations Strategy (RIS) and Regional Innovation and Technology Transfer Strategy (RITTS) of DG XVI and DG XIII of the Commission, with more than 60 European regions going through the policyplanning process.*

(2) Transfer of Strategic Intelligence practices in the Nordic countries: *Among the Nordic countries (here especially, Denmark, Finland, Norway and Sweden), there is a long tradition of mutual collaboration in the conduct, funding and promotion of research activities. Collaboration and exchange of ideas include policy initiatives to support R&D activities. These countries have diffused models of research funding and organisation to each other.*

In the early 80s, the Academy of Finland adopted a model of research evaluation from the Swedish Research Council for Natural Sciences and modified it somewhat. The Academy of Finland commissioned panels of peers consisting of international experts to evaluate whole research fields - in Sweden, the same procedure had been applied to the projects funded by the research council and originally had been a replacement of ex post reports of the projects. The main criterion of evaluation was scientific quality. The first evaluation, that of inorganic chemistry, which used this model was completed in Finland in 1983. Thereafter the Academy of Finland has commissioned 25 evaluations of research fields and research organisations using the same procedure. The Danish and Norwegian research councils adopted the evaluation model from Finland and commissioned similar evaluations from mid 80s onwards. The model of using an evaluation panel consisting of peers from other countries to assess research quality was applied not only to evaluation of research fields, but also to evaluation of research centres. Panels of international experts were also used to evaluate research initiatives, such as research programmes, but in the latter as well as in evaluation in general, evaluation criteria have increasingly included fulfilment of broader societal missions and the strategic importance of the activities for socio-economic development.

One of the principles adopted in evaluation in all Nordic countries relates to the openness and public nature of evaluation. The reports produced by evaluation panels are published and they are available to everyone inter-

ested. This principle has its roots in the tradition of openness that can be observed in most areas of public administration in the Nordic countries. Publicity in evaluation is important for both the transparency of the evaluation exercise and the legitimisation of the activities to be evaluated.

The Nordic countries have since adopted a wider variety of evaluation procedures; however, they still continue to apply the procedure described above. Some of the evaluations using this procedure cover a wide range of activities within one evaluation, such as health research in the country, which brings about new difficulties. The use of expert panels in evaluation is a modification of the classic peer review, which presupposes expert knowledge of the research to be evaluated. The more the area to be evaluated is expanded, the less the latter holds true for all research in the broad range of activities.

In the Nordic countries these days, evaluation is a routine activity and applied to most public initiatives in the area of research funding, to research programmes, research centres, and new initiatives in research and technology support. As said above, evaluation criteria, methods and uses have multiplied. We can conclude that the Nordic countries have developed an evaluation culture where evaluation is one of the mechanisms by which public accountability and transparency of public administration is being provided. Evaluation has also evolved into a mechanism for negotiation over changes in R&D organisation and funding.

It should also be mentioned that these countries have been influenced and they have influenced the R&D indicator activities of the OECD, particularly, in the field of R&D output indicators for the assessment of universities. The OECD was in important forum for discussion of such indicators in the 80s.

2.4.4 Conclusions on Inter-linkages between the Three Forms of Enhanced Intelligence Tools

Our brief survey of existing practices and experiences with the integrated use of the three intelligence tools for innovation policymaking TF, EV, TA in various European countries and the EU Commission leads us to the following conclusions:

(1) Although examples of integration between the three bodies of experiences can be identified in several countries, there is no systematic effort, neither by policymakers, nor by the research practitioners, to combine the strategic intelligence coming from the three different traditions. The synergy that could be gained by using a combination of methodologies, issues, processes and so on, is not exploited in the most effective manner.

(2) Industry has an older tradition of combining approaches when defining strategies to assess uncertain (technological) developments with potentially wide impacts, both commercial and societal.

(3) Present empirical and well-documented examples of learning from cross-border learning show that it is valuable to learn even from different institutional settings, to avoid repeating the mistakes and to pick up good practice experience more quickly.

(4) There is no "blue-print" of how the tools of EV, TF and TA can be best combined. The configuration should be considered from case to case, depending on the objectives and scope of the policy decisionmaking process in question. The ASTPP network does not advocate integration per se, but an integration for those cases where a combination of information looking back in time, looking at current strengths and weaknesses, looking at a wide set of stakeholders and at future developments can improve the insights needed to choose between strategic options. This also asks for further exploration of the limits of integration to avoid unnecessary "heavy weight" exercises.

In general, we could state that the greater the potential socio-economic impact of technology and innovation, the stronger the case is for using the full array of available techniques for strategic intelligence.

3. Requirements for Distributed Intelligence

HAMLET. A man may fish with the worm that hath eat of a king, and eat of the fish that hath fed of that worm.

KING. What dost thou mean by this?

HAMLET. Nothing, but to show you how a king may go a progress through the guts of a beggar.

William Shakespeare, Hamlet, Act IV, Scene 3

Top-down or bottom-up? Distributed Intelligence pervades competing kingdoms' borders and hierarchies. Knowledge gained and used in one place – be it a prominent or a less favoured one – may well be consumed and invested into the production of better knowledge elsewhere. The infrastructures and architectures of an emerging "digestive system" of Improved and Distributed Strategic Intelligence deserve a more detailed consideration, helping to shape their future development.

In the first Chapter we emphasized distributed policymaking as an important characteristic of the present situation, and one which will become more important in the future. We also underlined the variety of actors involved in innovation policy, including the growing importance of private actors, of associations and consortia of private actors, as well as public-private combinations.

Following this, Chapter 2 then discussed methods and best practices of enhanced tools (ET) for strategic intelligence (SI), structured according to three types of SI, Science and Technology Foresight (TF), Policy Evaluation (EV), and Technology Assessment (TA). While we explored possibilities for integration, and offered concrete indications, we want to emphasize that there will always be much to gain from customised exercises involving combinations and permutations of EV, TF and TA, for all can be seen as pre-decision tools which look back to see what we can learn from the past (EV), consider potential options for the future (TF), and examine the implications of particular lines of action (TA).

There is also much to gain from their systematic use and exploitation in multiple settings, with outputs accessible and distributed across actors, levels, environments etc. The challenge we take up in this chapter is then to realise the potential and transform the present supply into what we have called *"Distributed Intelligence" (DI) and supporting "infrastructures" of Strategic Intelligence*. We put quotation marks around "infrastructures", because these should not be designed as services in their own right, but be derived from the functions they have to fulfill in the multi-actor world of distributed policymaking (for example, it need not be, and probably should not be, a separate, all-encompassing single "service", for which one institute is responsible).

One should think in terms of an architecture, in the same way that computers have specific architectures, which allows production and use of intelligence. With computers and networks, one speaks now also of distributed architecture. In the case of DI, the architecture refers to its distribution over actors, levels, sources of supply and the interlinkages, and has cognitive (nature and quality of intelligence), institutional and socio-political aspects. In DI, supply and demand are linked through mediators, forums and *facilitating intelligence "nodes"*, an intermediary area of spaces and competencies, which guide and enable supply, and maintain DI so as to serve various demands. An improved Strategic Intelligence architecture, linking various DI infrastructures, will have to support the intermediary area, enable further distributed policymaking, and enhance its quality. By *locating DI in the intermediary area* (and supporting it), we go some way in resolving the question of proprietary information (there is some similarity with Electronic Data Interchange, where information in one supplier-customer cluster remains proprietary to that cluster, but the organization of the information is done in the same way, enabling transfer.)

This chapter will address the challenge in three steps: firstly (section 3.1), a consideration of *evolving configurations* in which distributed intelligence is visible, or can be made visible through special DI infrastructures. We shall evaluate actual and possible configurations, and identify first-round requirements.

Secondly (section 3.2), we shall assume a world in which *improved Strategic Intelligence infrastructures*, based on ET and DI, are realised, and use the device of writing *"fictions"* about future uses of DI to find out which building blocks are necessary to have such a world function adequately: (section 3.2.1) an SME considering a strategic technological move; (section 3.2.2) a region considering its new "education, research and innovation" contracts with the nation and the EU; (section 3.2.3) developing a new EU technology programme; (section 3.2.4) facing a new collective risk - the Ebola virus. Such speculations are necessary to transcend present-day's user needs which may well be too conservative (and too specific).

Thirdly (section 3.3), we shall offer a *draft of an architecture* of an improved Strategic Intelligence. This cannot, for obvious reasons, be a definitive design and list of building blocks, but it forces us to imagine potential future developments which will become more concrete and specific only in the course of time.

3.1 Evolving Policy Configurations and Distributed Intelligence

Initiating and exploiting new policy tools in a systematic fashion across innovation systems will demand new structures, institutions, protocols and linkages within these systems. There is no single "correct" configuration of tools, procedures, institutions and structures which can be used in all contexts and situations.

In systems terms, intelligence is necessary for the functioning of a complex system, and it has to have the "requisite variety". In the multi-actor and varied systems of science and technology policymaking and the policy domains they address, such intelligence must be distributed. But it must also have some coherence: be more than outcomes of ad-hoc requests for strategic information from research organisations, consultancy bodies and science and technology scholars. And there must be some quality assurance.

The responsibilities for provision, maintenance and quality of the intelligence will also be distributed. One can discern elements of this already in present situations. In our brief examples, the focus is still on national-level policy configurations, while one could (in fact, should) argue that regions and supra-national organizations will become more important as policy arenas, and as configurations which link up actors, including private actors and public-private interactions.

Historically evolving policy configurations

One can identify different development paths of the application of strategic intelligence tools in European research systems. In some cases, for example in France, one can also see certain life cycles of planning approaches.

Centrally controlled planning approaches, also for science and technology, have a long standing in the French administration. The institution of "planification" and the "Commissariat général du Plan" had considerable influence during the 1970s and early 1980s. Prospective, a version of TF, was an important element of national policy planning. This whole approach lost momentum and down-cycled since the mid 1970s. In fact, at the central governance level it almost disappeared in the early 1980s. In partial contrast, in the course of the 1980s various EV procedures were developed and implemented, for projects, programmes and institutions, and centrally as well as decentrally, at several hierarchical levels. By now, there is a strong tendency toward decentralisation of governance, also in science and technology policymaking. As a consequence, the competencies and spaces for the development and use of integrated strategy policy approaches are less evident than they were. They do survive, less visibly but sustainably, in a variety of decentralised policymaking arenas.

Another policy & planning life cycle is seen from the mid 1980s onward in Spain and Portugal (and to a lesser extent in Greece), induced by their entering the European Community at that time. They took over the experiences of the larger, industrialised member countries, but selectively, and adapting the models to their own circumstances. The governmental science and technology bureaucracies in Portugal and in Spain seem to use EV procedures and TF activities (but little TA) as coordinated instruments of policy planning – at least conceptually – and for funding allocation decisions. The existence of the European Union, and in particular its interventions through the Structural Funds, have stimulated and strengthened this attempt to modernise. One could speculate as to whether these "late comers" in S&T policy planning will become the avantgarde of tomorrow.

Since the early 1990s, new strategic S&T policy planning activities came up in many European countries, driven on the one hand by the political-administrative system calling for accountability and for strategic orientation, and on the other hand by research institutions and intermediary bodies in search of new agendas and fighting for their budgets.

The strong dedication of the UK TF activities to inform funding allocation and research agenda building can be read as simultaneous identification and ex ante EV of policy alternatives. The link with agendas of research organisations is clear, in particular in the case of the research councils, and special funding has been made available for research on key themes. Similar, but more open-ended approaches have developed in the Netherlands. In Germany, integrated use of TF, TA and EV occurs, but only within the bounds of specific policy studies. There is a growing interest in strategic debate on future science and technology policies, which can be interpreted as an attempt to create openings in the present distribution of roles, power, and funding traditions in science and technology. In a similar vein, decentrally located actors in France appear to mobilise TF, TA and EV activities to create and strengthen future influence and power of their institutions or regions.

One conclusion that can be drawn from recent developments, highlighted by these brief examples, is about mutual transformation or co-evolution. Intelligence has always been a policy resource, but strategic information is now created on purpose, and is taken up in policymaking and political strategies. Structural and institutional settings influence both production and uptake of strategic information, and if one takes the longer-term view, one sees that they are themselves transformed by it.

A similar point can be made about configurations at the level of the European Union (including relations to member states). Not surprisingly, given the complexity of the partly contradicting needs and requests of changing research systems, embedded in multi-actor and multi-level policy-negotiating systems, the European Commission has some difficulties in linking up systematically with the various actors and structures (and vice versa). Presently, the European Commission itself is demanding the implementation of "professional, learning-oriented" management practices of public action[43], embedded in "reflexive" alignment procedures amongst S/T policy actors - though the concrete planning measures suggested - e.g. an "objective" EV resp. rating of research actors throughout Europe - do still look quite mechanistic!

Nonetheless, since – as a consequence of the ongoing economic integration – a further adaptation or aggregation (or even integration) of the various regional and national systems of innovation in Europe is at stake, there is a need for such "intelligence" also on the transnational, European level (be it the European Commission or other, new institutions of European governance): the "European level" may act as a lead user, as well as a facilitator for other users. It is also an actor at a high level in

43 See Caracostas, P. / Muldur, U. (1998): Society, the endless frontier – A European vision of research and innovation policies for the 21st century, Luxembourg/Brussels (Office for Official Publications of the European Communities) (EUR 17655), 161ff.

the hierarchy, with a potentially wide scope. This is an advantage, but also creates risks of centralisation.

A priori design requirements

In this section, we go one step further than a consideration of national and European-level policy configurations, and consider concrete possibilities for distributed intelligence and a supporting service. We draw upon an earlier report (discussed in the ASTPP Strasbourg meeting[44]), which outlined a DI service in which the Commission of the European Communities might play a leading role. This consciously avoided an approach with centralized and hierarchical information gathering and management systems as these were put up on the drawing boards of old-style planners, and are to some extent the approach of national "central" intelligence agencies. The extent of overview and policing required in such a centralised system make it unmanageable, even if it were desirable. *Key design requirements* emerging were:

0 the need to take the *"real" and somewhat dirty world* of policymaking into account. A middle ground is created between overly rationalistic decision support approaches, and fatalistic (or entrepreneurial) ad-hoc exploitation of opportunities.

1 the service has to be able to *survive*: the investments required must be made, and continue to be made.

2 the *"pedigree" of the information* (concept borrowed from Funtowicz and Ravetz, who used it as one of their quality dimensions of risk information)[45] must be traceable (there are various forms of hypertext linkage which could do this to the required degree of sophistication).

3 since the *value of the information is different* for the different actors and audiences, additional information on values of actors, positions in strategic games etc can be added (as in the so-called social maps used in TA), and then used to open up two-way communication channels and/or the creation of *spaces (or forums) for interaction*. Social maps, provided by analysts, are one way to enable the latter; other, more political processes may also be invoked.

There is an element of process rationalism in the elucidation of the requirements listed above, both when provision of information on pedigree and on social maps is presented as improvement of negotiation, and when the introduction and spread of DI service is seen as a "good thing". The additional claim that "finally" the dilemma

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[44] Kuhlmann, S. / Smits, R. (1996): Some Future Options for European Science and Technology Policy Planning. Preliminary Recommendations of the Thematic Network "Advanced Science & Technology Policy Planning (ASTPP)" regarding the Fifth Framework Programme and the Influence of the Integration of Technology Foresight, Technology Assessment & Evaluation Procedures. Proceedings of the ASTPP Workshop in Strasbourg, 16 December 1996, Strasbourg/Karlsruhe (Mimeo).

[45] Funtowicz, S.O. / Ravetz, J.R. (1990): Uncertainty and quality in science for policy, Dordrecht /Norwell, MA, U.S.A. (Kluwer Academic Publishers)

from which strategic decisionmaking suffers can be resolved is surely too ambitious, but it adds a further element of rationalism.

All these good things hinge on the efforts of leading actors, which help to overcome thresholds and barriers. While S&T policymaking may at present be severely "under-intelligenced", the upfront investments in getting a DI service that is practically useful are high, and still uncertain. A coalition of public sector actors, with perhaps a few private actors who permit themselves a longer-term view, is probably necessary to start up a DI service. At the national level, the French "Observatoire des Sciences et Techniques" would be an example of such a construction (and an interesting case study for our argument).

Reflecting on the initial assumptions which underpinned these requirements, we also see that one encompassing service may not be feasible (perhaps not even desirable). There may well be a variety of intermediary areas, each of them served in its own terms, but then linked (which requires translations, and some inter-operability).

There is specific, customised intelligence for actor X or Y in configuration A or B, and there are bilateral and multi-lateral exchanges. The key point is that strategic information always also functions as a *negotiation medium*, and thus becomes shared (even while still contested), and distributed, more or less available within the arena and to some extent also outside (requires packaging, functioning reservoir). Such processes occur anyway, but one can support them so as to bring out the collective value. For particular intermediary areas, but especially for the overall mosaic of areas and support services, those general features which link up with the normative principles set out in the beginning of this chapter are particularly important. This leads to further requirements of a general, process- and quality-oriented nature. The design of DI should facilitate (see also section 1.2):

- analyses of *changing innovation processes*, the dynamics of changing research systems, changing functions of public policies;
- the identification of *diverging "frames" of actors' perceptions*;
- a more *"objective" formulation of diverging perceptions* of (even contentious) subjects, offering appropriate indicators and information-processing mechanisms;
- the organization of *mediation processes* and "discourses" between contesting actors (or between representations of their views).

In the following section we present several "fictions" of elements of an Improved Strategic Intelligence. They are presented as "short stories"; we named them "fictions" and note "visions" in order to underline that they are they are *deliberately constructed and speculative*, based on the assumption that creative forward thinking may stimulate the design of related architectures.

3.2 Stylized Fictions

The objective of these stylized fictions is to take "classical" problems encountered today and suggest in which ways an architecture of Improved Strategic Intelligence – based on "Distributed Intelligence" and active "interfaces" – would help actors in various innovation policy arenas in their decisionmaking processes.

The speculatively narrated situations below aim thus at highlighting processes, issues … and risks. Each fiction is followed by comments highlighting specific dimensions of the global architecture. These will help in further articulating "infrastructures" needed for this architecture of distributed policymaking and intelligence to exist.

3.2.1 Fiction 1: An SME Considering a Strategic Technological Move

It is the year 2005.

The managing director of Biomat had a problem. Her firm had spun out of the European Advanced Study Institute to build replacement human organs using metagenic technology. With the support of regional governments, the company had won key clients in the health sector and now employed 50 people–equivalents based at its two sites in Ibiza and Rotterdam. After two years of success, Biomat was at a crossroads. Should it stick to metagenics which was costly and prone to production problems, or should it move into the newly emergent ultragenic approaches which promised great cost reductions but were unproven?

In her early career, the Biomat manager had avoided government advice and schemes after some bad experiences of their limited knowledge of the bioparts sector. The R&D programmes always seemed to favor the strongest lobbies and had made some spectacular wrong decisions. Happily, things had got much better since the launch of the ENDBITS, the European Network of DistributedBureaux of Intelligence for Technology. She switched on her videophone and asked it to trace the head of the regional innovation bureau, the RIB …

RIB helped her to prepare a videonote on which technology to choose. It ran a standard search on the European Foresight Bank, an electronic tool which logged all of the world's foresight outputs and used AI algorithms to cluster their findings and build scenarios. The recent expert assessments from Germany, Greece and Korea all looked good for ultragenics. It seemed feasible and the inter-related technologies were in place. The RIB advised that for health technologies, it was insufficient to rely upon only foresight views –

however positive. Social and regulatory problems were also possible and the adviser had heard of some problems in Austria. The TA directory identified the main Austrian experts and RIB contacted them. The reply confirmed their suspicions. Ultragenics had been subject to ethical challenges from a local religious foundation who were organising a boycott. RIB called for more information and scanned the recordings of the Consensus Conference. Relief! The objections were based on a misunderstanding of the procedures for ultragenics (which unlike earlier approaches did not depend upon foetal cells) and the citizens jury had come out in favour, subject to certain restrictions.

Biomat was ready to launch its ultragenics research programme, but was worried about the cost. The RIB pointed out that all three of the European Research Framework Programme agencies offered support in this field. In this case, they advised joining the programme headquartered in Prague, as a recent evaluation had shown it provided the fastest turnaround of proposals and claims, and hence had attracted a higher quality of potential partners. The programme was also a direct result of one of the foresight programmes they had just consulted.

"Thanks RIB" said the Biomat manager. "Life without ENDBITS just wouldn't be the same."

Comments on fiction 1: Fiction 1 presupposes the existence of three common resp. global "infra-structural" elements: a TF data bank, a TA directory and a network of "trustworthy" innovation bureaus. Let us further analyze these components, since they help in identifying three crucial requirements for enhanced DI to exist.

a) There has been a generalisation of TF exercises as a normal instrument to prepare for future actions. Since activities and specialisation differ from "place" to "place", many TF exercises have taken place or are taking place. The need progressively arose for a *"enabling structure"* which would allow free access to all the exercises undertaken under public auspices. It is well known (see Chapter 2) that such exercises have a double dimension, that of identified shared anticipations between "experts" and to foster linkages, interactions and shared visions within given communities. This second objective of course remains "local" i.e. linked to the places which developed the different TF exercises. Still, being supported by public funds, it was considered that a better use of public funds could be achieved if at least elements of the first dimensions (i.e. results about anticipations) could be accessible for other exercises and the public at large. This gave rise to a joint decision at the EU level to support such a "service". The only thing we know here about this service is that it takes the form of a bank which stores results from most world exercises undertaken. We can hypothesize three further elements :

0 the need for a central team to *manage and maintain the service*. For this, it is not necessary to think of a European institution, we can also think of a delegation to

a specialized company or to a joint undertaking of public institutions specialising in technology studies, or TF work.

1 the need for *rules to access it*, for instance, the need for users to become acknowledged customers and different tariffs for access depending on the type of customer, a large firm with internal capabilities, an "intermediary" such as the above mentioned innovation bureau, or political stakeholders such as local or regional authorities, recognised non-governmental organisations, chambers of commerce or professional associations.

2 the need for *adequate resources*, and there one could think of a policy whereby basic "core funding" allocated by EC would reduce over time, the service aiming at being self-sustained once initial investments in the development of the bank have been paid for.

b) The fiction highlights a second feature, the existence and role of regional "innovation bureaux" and a related European network (ENDBITS). Their existence reveals an understated assumption which is that, if most large organisations have their in-house capabilities, such is not the case for small entities, however "front tech" they might be, hence the development by a large majority of regions of Innovation Bureaux. The terminology is deliberately disconnected from the existing structures which often only highlight technological dimensions of mediation, such as technology resource centres for instance.

The example also assumes a great trust in the capabilities of such "intermediary structures". How can it be the case, especially if the number of innovation bureaux is such that, within a federation like the EU, you probably have more than 500 … One can hypothesize the existence of a European association which has gone further than the sole identification of good practices and has developed an "accreditation office" based on the adoption of agreed standards of quality and in charge of labelling local innovation bureaus (and of monitoring/evaluating their performance). What is underlined here, is the *need for quality assurance*, and the fact that self-organising mechanisms can be as powerful as top-down regulatory approaches. It also leaves room for a plurality of local institutional arrangements for such innovation bureaus.

c) Finally, Fiction 1 also considers technology as part of societal issues and thus subject to political debates with "consensus conferences" as a normal process for addressing ethical issues. So that, as for TF, the need for a central structure taking hold of all TA debates and especially of all "consensus conferences" has also been recognised. But it is of a different nature than the TF one. In the TF case, the bank capitalises "results", i.e. anticipations made on potential technologies. For TA, it has been considered that this is not enough. Information could be easily gathered in each TA exercise about the issue addressed, the compromise arrived at, the promoter and main actors of the exercise, still this would remain of limited interest since the most relevant elements were specific to each TA and very difficult to gather in a data bank, especially positions taken by given stakeholders and the way they evolved over time, elements which proved crucial in the compromise arrived at, the potentiality of transportability or generalisation of the compromise arrived at, etc. Thus the choice of a "directory", the role of which is to enable *direct connections between relevant actors*.

Again, nothing is said here about the conditions under which such a directory operates. Many options could be open, and why not one where this is developed under the auspices of the European association of parliamentary "technology assessment offices" (which exist in all EU national parliaments, whatever their specific terminology in each country, and even have been established in certain regions) …

3.2.2 Fiction 2: A Region Considering its New "Education, Research and Innovation" Contracts with the Nation and the EU

February 13th 2007:
Meeting of the Economic and Social Council of Region X.

The object of the meeting was to deal with the renewal at the end of 2008 of the "EU-Region" and "Nation-Region" five year contracts dealing with education, research and innovation policy. This will be the first time such contracts are negotiated together and coordinated. The issue of the meeting was to decide how to prepare this negotiation due to start exactly in one year, and more specifically how to evaluate and put in perspective the set of regional projects looking for joint funding. These projects, which the council was presently receiving, covered a wide range of activities: scientific equipment and infrastructures for public labs, industrial facilities for testing specific innovative products or processes, training programmes linking firms and university departments, virtual libraries in specialized domains. More than half of them are continuations, having already been funded under the previous (and still on-going) contracts.

Two points were considered central for the regional proposal to be "robust".

(1) Half of the projects being continuations, evaluation was a first important element. The classical "expert evaluation of projects' achievements", as required by both contracts, was not judged sufficient, so the council decided to undertake an evaluation of socio-economic effects of funded projects. This decision was largely influenced by the President who had just returned from the annual conference of presidents of regional Economic & Social Councils, where a full day, organised by the "European Association of Evaluators", was devoted to "best practices in programme evaluation". He learned there that methods were now considered reliable even for evaluating effects of research infrastructures or teaching programmes, two central features of the regional programme. He also had been very much impressed by the accreditation pro-

cedure which was in use and showed that within his own region and the neighbouring ones, at least six entities were accredited, rendering it feasible to have results within a six month period.

(2) A second important debate dealt with the wide spread of projects received. Could the region present such a patchwork for negotiation? Or should not there be a clear expression of the region's objectives and directions? Finally, after a quite confusing debate, an agreement was reached about the focusing of the region's objectives. But, faced with opposite views, the council only agreed on two main criteria: the region should focus on "promising scientific and/or technological fields" and at the same time theses should favour the development of "technology districts", a fashionable notion which had sprung from the successful "filière" approach developed these last years in quite a few regions such as Alsace. It was thus decided that the regional innovation bureau (which had been created three years ago both to manage projects and develop technology transfer) would be in charge of making a proposal for the next session in two weeks time.

February 15th: Meeting of the board of the innovation bureau. The objective is to prepare a proposal to the council. Very rapidly members arrive at the conclusion that only a foresight exercise will help in assessing these areas where there is both a regional potential and a will to develop joint activities. It is also rapidly agreed that, due to the short time left, account must be taken of already existing work. A review is requested from the head of the bureau.

February 22nd: Meeting of the board of the innovation bureau. The Chairman of the Board confirmed the agreement of the President of the Council to undertake a foresight exercise. The head of the bureau then presented the results of his enquiries. First, mobilizing the recent regional innovation survey, he suggested limiting the scope to seven areas where there were at least 10 innovating companies and 5 public research groups. From what he had been told by the secretariat of the council, this corresponded quite well to the major projects received (especially for scientific equipment and training). This was agreed upon, but it was also said that the innovation bureau would plead for room to be left for innovative, exploratory projects not within these seven areas, a figure of 20% of the funds asked for, would be suggested to the council.

His further enquiries into the European TF bank had shown the head of the bureau that, though results were accessible, the situation differed depending upon the area. In 5 of the 7 areas, two very different types of foresight had been undertaken: on the one hand, there were the results of the last joint German-UK Delphi enquiry which he considered in each field too general, "science pushed", and long-term-oriented; on the other hand there was the recent national survey on "critical technologies" for the nation, which was shorter term, more specific and, even in some areas probably too specific. It *was decided that account should be taken of both and the proposal was to very rapidly devise a "one round" questionnaire as the source for further workshops aiming at a "common vision" and thus at a revised more articulated set of projects.*

But enquiries had also shown that in cotton-based textiles and ferrous metallurgy, no such exercise had been recently conducted, thus a fresh approach was needed if only to identify potential scientific and technological breakthrough. Here, it was felt necessary to trespass the borders of the region and to see whether a larger professional exercise could be organised. The chairman of the board was charged to enquire into the issue further.

February 28th: Meeting of the Economic & Social Council of Region X. The terms of reference for the future evaluation presented by the "project monitoring bureau" of the council are rapidly agreed upon. The agreement for a Delphi exercise focused on the 7 areas is also confirmed. As suggested by the chairman of the innovation bureau, the latter is directly in charge of the 5 areas while the council agrees to fund half of the costs of the professional foresight exercises to be undertaken by two specialised technology resource centres, the professional associations having agreed in principle to fund the other half. The council also requires the two associations to commit themselves before the end of March, otherwise the bureau will have to devise another approach.

Comments on fiction 2: As fiction 1, but in a different setting, this fiction requires the existence of common "resources" local policy arenas can draw upon. We find here again the Foresight bank, and at the same time, fiction 2 makes it clear that it would not be realistic to think that some all embracing exercises can be enough to feed it. This is an endless process, not only because it has to be periodically repeated, but also because coverage of all activities and all areas of knowledge cannot be imagined and will thus *always require "fresh" exercises* and *renewed combinations of actors and levels*, as exemplified here by the two areas not covered in supposedly "older" fields.

The reader will also notice that trust in the innovation bureau is quite high, no doubt due to the *accreditation mechanism* pointed out in fiction 1.

The third element this second fiction highlights is a central phenomenon in public research management, the generalisation of EVs and the corresponding emergence of a *strong professional association*. This has not only developed, as for innovation bureaus, an accreditation mechanism, but is also heavily engaged in disseminating knowledge about it (as witnessed by the session organised for regional presidents of "economic & social" councils). Of course, other directions could have been taken, for instance, pushing towards a public label (as was the case e.g. in France for consultants in energy saving by the national agency in charge of the related issue).

However, this seemed difficult to imagine taking into account the lasting debate upon public organisation of EV and the difficulties encountered in the 1990s for promoting European co-operation between bodies, services and others in charge of EV in the different EU countries.

The final point this fiction illustrates is an important message for this report. Enhancement of "instruments" (as is witnessed here for EV) and of *"distributed intelligence"* (as is enabled for instance by the TF bank) *should not be confused with "improved strategic intelligence"*. Fiction 2 gives an account of this latter process, whereby, thanks to the new "infrastructure" developed, locally rooted decisionmaking processes can be enhanced, thanks to the specific shaping and gathering of the intelligence required by the specific situation faced.

3.2.3 Fiction 3: Developing a New EU Technology Programme

September 2007.

The newly established "Joint Office for socio-technological programmes" between the European Commission and the European Parliament is under multiple pressures. The Office is the result of new procedures adopted for the Sixth Research Framework Programme of the European Union (FP6). No clear pattern for putting a problem on the political agenda has yet emerged while candidate actions multiply to get hold of the billions of Euros that are still pending!

It is true that major Technology Foresight exercises are held every five years (if only to please the Japanese), and these produce listings of promising technologies. The 2006, UK-led Foresight exercise, as well as the parallel Japanese Delphi Foresight, have identified new solid-state technologies which allow much higher conversion rates of solar to electrical energy. This creates new possibilities for centralised solar energy power plants. The Office is particularly keen to pursue this lead, and perhaps establish a development and demonstration programme, one reason being the disarray of the nuclear power programme, even in France. Quite a number of countries have passed laws against recycling nuclear waste. The French Parliament prolonged the "search" period during which no irreversible solution is to be taken from 2006 until 2015, and the technically favoured option, incineration by a "rubbiatron", faces strong opposition from citizens of the area where the test bed is supposed to be located. A European consensus conference about nuclear waste transportation ended in confusion, rather than agreement.

Alternative ways of providing electrical power should be developed, and be part of the portfolio of RTD programmes. The Office prepares itself well by inviting C^2, the Consultancy Consortium, to prepare a background report on *the new solid-state technology for solar power and its societal impacts. The Consultancy Consortium, established since 2005, led by the respected consultancy firm John D. Big, pools the dedicated TA and TF studies of its members (which include the consultancy arms of some major research universities). The data remain confidential, and the Consortium charges a fee for delivering analyses based on them. An important feature of the Consortium is that they recognise a civic duty to deliver such analyses with the public interest in mind. This rule allowed the universities to come in, and shifted the role of the Consortium from that of a self-interested actor to a node in the network. Members of the Consortium profited from their access to this clearing house, as well as from the status membership conferred (even if they had to accept the obligations that went with it).*

The action of the Office coincided with the publication, by the Association of Mediterranean Regions, of a study of solar energy options and critical issues, which ended up privileging "centralised thermal solar" as the most promising solution. As environmental groups, criticising the required concentration of mirrors for transforming the last untouched landscapes of the Mediterranean zone, were quick to point out, at least one of the champions for these plans was member of the Joint Office. Whether the coincidence was indeed a case of lobbying was not clear, but the suggestion added force to their general argument that major public investments should be postponed until the new technology has proven its efficacy, its reliability and demonstrated cost-effectiveness.

While the Office awaited the report of the Consultative Consortium, it realised that it needed further, independent inputs to overcome a possible stalemate between proponents and opponents. In Europe, there was no equivalent to the advisory activities of the USA Academy of Sciences. There had been attempts to shift or extend the make-up of the European Science Foundation in such a direction, but even if this had been successful, there would still be the connotation of a scientific establishment, which would create problems – as had happened with the advice of the USA Academy of Sciences. Staff in the Office suggested to use the Delphi Foresight exercise, with its broad consultation, to identify relevant experts. Some regions in Europe had exploited Delphi exercises for such a purpose, and this could be repeated at the European level. While the proposition was attractive, it was necessary to have some quality assurance, over and above the value of the arguments put forward. Of course, there was the Repository of R&D Evaluations, set up by the European Universities' Rectors Conference, which would allow one to position academic experts. The Office was confronted with a dilemma: whether to go for recognised expertise, as evidenced by membership (and status) in professional societies and by scores in research assessment exercises, with the risk of being accused of an establishment bias; or open up to all comers, but then have to develop and apply quality criteria of its own.

The Office opted to overcome the dilemma in the short term by setting up an RTD programming version of consensus conferences. (It took care of the long term issues also by putting pressure on the European Science Foundation, Academies of Science, and Institutes of Advanced Study to devise an open-ended quality assurance system.) The conferences were exciting events for the participants, not in the least because of new information and communication technologies: whizz-kids from Big Heart Company introduced comic strip balloons offering URL linkages to key words as well as to experts speaking out, which allowed all participants to contextualize what was being introduced.

The programme proposed to European Council and European Parliament is novel in two ways. One, it is not a finished programme, but linked to ongoing activities of actual and prospective participants. Two, as a programme, it is implemented in two stages. There is a framework for articulation and implementation of programme goals. And secondly, there is implementation of the programme, in this case delegated to other actors, like the Association of Mediterranean regions which has been very active in organising consensus conferences in all regions.

Comments on fiction 3: This third fiction takes hold of the elements mentioned before: actors normally mobilize in their argumentation the results of different TF and TA exercises which have taken place to position better the new option they propose.

When faced with "scientific" evaluations, policy actors are rarely equipped to undertake it internally (this is strongly underlined in chapter 2) and thus need to delegate it to external "bodies". Here we have moved from the dominating present feature where "ad hoc committees" are created, to *delegation to "reliable" and "credible" actors,* including a private-public partnership like the mentioned Consultancy Consortium C^2, in charge of organising an adequate EV process. Alternative "infrastructures" for the global DI architecture could have been thought of, such as European associations of learned societies, or a European gathering of academies of science.

This third fiction highlights another central phenomenon: without an evolution of present decisionmaking processes, there is no need for more to be done than just enhancing present practices. The fiction first takes for granted a feature put forward in chapter one: the *locus for innovation policymaking has dramatically enlarged*: it is no longer the sole realm of national governments, with some "issues" delegated to a marginal EU framework programme. Regional policies have multiplied (as illustrated by fiction 2) and are by then fully fledged policy actors. Some even consider that certain Non-Governmental Organisations (NGOs) addressing given problems (such as neuromuscular diseases or cystic fibrosis – to take existing examples) also play a similar role. Thus articulation between "policy arenas" is a central issue in the way to handle problems: in this fiction, "exploration" has been the initiative of an association of regions (which is different from a nation!), because they recognised the issue the project proposes to solve, as critical for them. It is not difficult to hypothesize that in a European Union made of 25 countries and probably over 150 regions, such assemblages will be the rule rather than the exception - what will then be the capability of a problem to be shared by all political levels?

3.2.4 Fiction 4: Facing a New Collective Risk: the Ebola Virus

Sister Francesca felt ill, more so than at any time in her 20 years of working in the remote areas of Central Africa. It had started suddenly and after 48 hours her compatriots had concluded that a quick return to the Convent, on the outskirts of Paris, was imperative.

The flight seemed interminable; to take off from Kinshasa at 25 minutes past midnight was bad enough, but the trudge through Brussels airport in eight hours time, to get the flight to Paris, would take all her courage. The food hadn't interested her. To make matters worse she had broken her wine glass, cutting her hand in the process. The stewardess had been kind, but Francesca wondered how the stewardess must have felt when she cut her own hand on the broken glass, which was liberally spattered with Francesca's blood.

Far away now in Africa a phone call had been made to Mother Superior in Paris, who had later telephoned the Convent's doctor. Dr. Louise Estaer pondered on that phone call; a nursing nun travelling home to Paris from Central Africa by a scheduled flight and with a high fever? Thoughts flitted through her mind, but she decided to wait until she saw Francesca. She called Mother Superior to accompany her. Both didn't like what they saw. After bringing Francesca back to the convent, Dr. Estaer consulted a colleague with African experience as a member of Medecins sans Frontières. Following his advice, Dr. Estaer immediately telephoned the US Center for Disease Control, in Atlanta. It took some effort to get past the "front desk" bureaucracy, but quiet forcefulness got her to the right office. Her story was listened to with patience. The advice was firm: blood samples to Atlanta and patient isolation were an essential precaution; a few hours would tell whether she had Ebola fever.

Three weeks later Dr Estaer was presenting the elements she had gathered to the sub-group on new viruses of the French commission of health safety[46]*. The blood samples had confirmed an Ebola type virus. The nun had died horribly.*

46 We remain here "traditional" in supposing face-to-face relations. One could easily replace that by a virtual meeting …

The nurse, who had clumsily managed to jab herself with the syringe after taking the blood sample, was fighting for her life after one of the few European survivors of Ebola, an Englishman, had been tracked down to enable serum to be prepared from his blood. Three days ago, Dr. Estaer had been contacted by the US Center for Disease Control, which had located the same virus on another person in Belgium. It did not take long to find out, with the help of the company's doctor, that this was the blood of the air stewardess, who had been infected during Francesca's wine glass accident: she had died in the small Belgian town of Ninove, with symptoms that had baffled the local doctors until, under the advice of another NGO, they had contacted Atlanta and sent them a post-mortem sample. And yesterday, she had been called upon by a Parisian hospital to see a patient just admitted, who had returned from a Central African safari holiday five days ago and was running a high fever with some unusual symptoms.

These elements had prompted her to ask for an emergency meeting of the sub-group. At the end of her presentation, the questions multiplied: Was Ebola, which everybody thought extinct, back? Or were we facing a new type of virus? Could the virus mutate to survive in Europe? Could it find a natural host in Europe (the African host of Ebola had never been positively identified)? Could the climate in some region of Europe become benign to a host for the virus without its mutation? But also, how could a very sick person travel unsuspectingly on a long-haul scheduled flight?

The conclusions of the sub-group were clear-cut. It was out of the question to wait any longer. Sanitary authorities should be warned so that emergency actions could be organised to monitor movements from that African region and the situation of all those which had returned in the last three months. The emergency sanitary net, created under the auspices of the G8, three years ago, was immediately activated.

At the same time, the "Dormont" scientific committee (called after the name of the first president of its predecessor which was created to cope with the BSE crisis) was informed. A video conference was organised the following day with its sister Belgian committee, examining evidence … and the following week, they proposed the European health research committee create an ad-hoc group in charge of monitoring the potential development of the disease and of engaging a research action. The procedure for getting funds out of the "European health emergency research fund" was engaged while the association of health research institutions was asked to organize a dedicated team.

Comments on fiction 4: This last fiction plays a different role. It is no longer to highlight the "infrastructure" needed for a DI architecture, but the fact that *no one unique "system" can be relevant*. "Intelligence" required is embedded in the situations it addresses. Thus numerous forms of aggregation, from the local to the global level, will take place, many of which will not separate different forms of public action (S&T being one among others).

Fiction 4 describes one such configuration, linked to a central public issue, health. It highlights another type of "distributed intelligence", based upon the capability to react to unexpected, i.e. uncertain, situations/events. The configuration proposed builds upon the existence of distributed knowledge – in this case, it is a "local" practitioner, a generalist, that puts facts together – but instead of pondering alone, she is able to emit a warning because "intermediaries" have been established for such situations of crisis – here the "sub-group on new viruses of the French commission of health safety". That we imagine a solution for handling immediate action, is not central to the purpose of the fiction (apart form highlighting the need for coherence in public action!). What is central is the *ability of these "intermediaries" to rapidly initiate a "research strategic process"* (we now know how helpful this would have been for BSE!).

This strategic process is based on two elements. It first presupposes the existence of a network of "national" scientific committees (which is activated in less than a week here!). This network is *another form of "Distributed Intelligence"* based upon the articulation of structured advice. Second, we witness here another set of conditions for flexibility – i.e. adaptation to changing conditions – which is the *capability of urgently engaging new actions* and the procedures that have been thought of "ex ante". These sprang from the ability to learn from past experience and one can assume here that EVs, through analysis of past problems and actions, helped in identifying relevant design criteria which such emergency actions must answer. In this fiction, the European committee has the power of creating an "ad-hoc research group", it can mobilize funds from the "European emergency research fund" and it can ask the "association of health research institutes" to organize a dedicated team to pilot the research action.

There might not be a need for having such coordinated sets of actors and formalized procedures to tackle unexpected issues, in all "sectoral policies" or for all "collective" or "societal" problems. Still, this last fiction emphasizes the *complex web of actors involved in distributed policymaking* and the two-level approach we propose, whereby only common elements of different situations are pushed forward, building what we propose to call the *"infrastructure" for the promotion of DI architectures*.

3.3 Which "Infrastructure" for "DI Architectures"? - Design Requirements

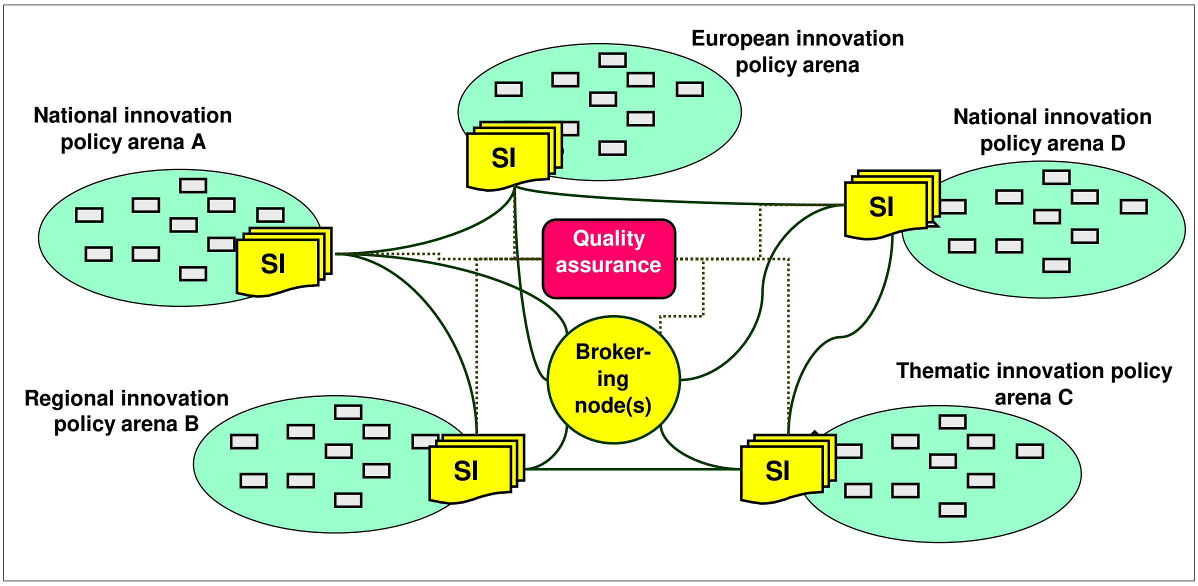
This last section builds up upon the lessons derived from and comments on the presented fictions. Of course, it is not meant to discover "fresh" lessons, since the fictions have been built on purpose to illustrate the qualities that we consider necessary for the transformations identified in the previous chapters.

All these fictions share first in common, as highlighted in chapter 1, the *multiplication of "policy arenas"*, no longer taking for granted that the "national" level is the central one to which all other levels, "regional", "European" or even "thematic" should be subordinate. We assume that in 2007, our reference year, this still rather dominant view will have fully faded, leaving on a similar footing, all these different "policy arenas". This brings to the fore the question of articulation between flexible combinations of arenas as is proposed in fiction 3. In our fictions, articulations are not simply linked to co-ordination in speeches or located in periodic compromises (as for framework programmes), but rather are embedded into procedures (such as the one linking health scientific committees in fiction 4), institutions (such as the imagined EP/EC joint committee for new socio-technological programmes of fiction 3) and devices (such as the joint contracts for education research and innovations imagined in fiction 2).

Second, these fictions also wish to highlight that *"Improved Strategic Intelligence" is not a global characteristic* that a "system" would share, but remains dependant on each "policy arena" and on its decisionmaking practices. Furthermore, within the same policy arena, these could very well vary, depending on the issue addressed: the reader has just to look at the present situation and, for instance, at the way in which health issues such as hepatitis C are addressed, to be convinced of the wide diversity of situations which will be found in our future Europe with 25 countries and probably over 150 regions! Furthermore our last fiction highlights the fact that co-operation patterns and modes of aggregation will depend upon the field or area addressed, that thus *many configurations in different "policy arenas" will be found* depending on the issues addressed: it will not be the same when dealing with health issues or competitiveness of industrial SMEs! Thus the terminology adopted: we propose to speak of "*architectures" inter-linking "policy arenas"* and more specifically inter-linking those, in the different policy arenas, involved in what we have termed "strategic intelligence" - i.e. in the management of relevant processes for information gathering and of "policy debate" between stakeholders.

Third, these fictions try to illustrate "*common" requirements* needed for such architectures to develop. These are "qualities" needed for an architecture to enhance distributed intelligence, or "functions" to be fulfilled for a given architecture to make a significant (radical?) change compared to an "improved" present day situation, i.e. a situation which would retain present day features while trying to overcome the existing fragmentation through more exchanges and even more co-operation between existing operators of the three major processes identified – EV, TF and technology assessment – in Chapter 2. To highlight these qualitative transformations we propose to speak of an *architecture of new "infrastructures" for Distributed Intelligence*, to highlight the set of new institutional and organisational arrangements that are required (see figure 3.1).

Figure 3.1: Improved and Distributed Strategic Intelligence (SI)



We have identified two major functions for this infrastructure dealing with: (1) *"quality assurance",* and (2) networking through *"centralising/brokering" facilities*:

(1) The concept of "quality assurance" is used here in a broader sense than usual in quality management, and includes attempts of actors to ensure minimum levels of quality and the assurance, with relevant audiences, that there is some quality control. Thus, it relates directly to issues of trust: what trust can actors in policy arenas have in all the "intermediaries" that are mobilised for preparation or conduct of policymaking. In the fictions we have indicate how bottom-up processes are important, in which various professional actors or bodies play a role. This includes (hopefully) the notion of 'civic duty' to do a good job, as it works, for example, in peer review within science (even if there are exceptions). One could think, in addition, of evaluators, innovation bureaus and the like organising themselves in European professional associations.

(2) The first three fictions highlight the importance of central "brokering nodes" in the circulation of information and in facilitating "horizontal" inter-linkages. Two very different types have been put forward by the fictions.

The first type corresponds to *"enabling" facilities*: this is typical of the TF bank mobilised in all three fictions. The objective is to render results arrived at in one place, directly accessible in another without requiring direct contacts between actors in both places. You do not need to contact the promotor of the UK or Japanese Delphi or the experts they have mobilized to take the results arrived at about solid-state technology (cf. fiction 3) and to argue for the feasibility of the solar thermal option proposed. The word "facility" is very important here, since it tells not only about the need for developing and maintaining/updating a bank, it also underlines the importance of "harmonisation" work that is understated in the possibility of entering results and thus facilitating their circulation: "compatibility" issues do not only raise technical "inter-operability" problems, they also raise issues about reliability, i.e. processes through which results are arrived at[47].

In the second type, the aim is to *facilitate direct contacts*. This is the process function of "technology assessments" or "consensus conferences" as in fictions 1 and 3. What is needed is not only to identify "assessments" or "conferences" which took place on the relevant subject and the compromises arrived at, but to take hold of the reasons why such actions arose, what argumentations were developed by stakeholders, and through what process "consensus" or "dissensus" was arrived at. In general, direct contacts between actors remain important. Thus the need for a different type of "central node", of a more classical directory which acts as a intermediary to facilitate direct connections between relevant actors.

The number of "policy arenas" and the variety of problems addressed – which the fictions gave only a limited idea of – pushes us to identify another type of "central node", no longer dedicated to a given "instrument", but more centred on processes and on the related combinations of instruments. The issue is here less the notion of best practice, but a topological notion, whereby one looks in a bank of experiences to identify those related to the problem faced, to see which processes and what combinations of instrument and level of deployment of each were used, hoping that these would be linked to reflexive analyses by their promoters about pitfalls and relative interest. The universe of situations is so vast that the idea of "best practices" does not seem appropriate; it is instead replaced by an idea of a *repertory of practices with indications how and why they functioned.* The repertory includes more and more strategic exercises over time, and there must be some structuring and winnowing, so that reference to the repertory will make new exercises more relevant and/or less costly (this is similar to the added value that the Consultancy Consortium in fiction 3 brings to its members). This provides for a third type of "central node" based on the establishment of repertories and *collective learning processes*.

To conclude, our position is that a world of distributed policymaking which takes into account the changing conditions of innovation processes, answers the political requirements of democratic choice of future technologies, and tries to limit public expenditure linked to decisionmaking processes, requires a new "infrastructure" for enabling both "enhanced tools and distributed intelligence". We have identified two functions this infrastructure should satisfy; ***"quality assurance"*** (for all the "intermediaries" or "filters" which populate the different policy arenas) and ***"central networking nodes"*** for facilitating horizontal linkages and the circulation/ transportation of knowledge (between policy arenas).

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47 The second cycle of the UK Foresight Programme has moved in this direction with the advent of a "knowledge pool" (see Chapter 2), a moderated web-based facility for foresight-related knowledge with public access.

4. Enhancing Distributed Intelligence for Innovation Policymaking on the European level

In the preceding chapters we have (1) outlined the basic concepts of TF, TA, and EV, their state-of-the-art with respect to methods and practices as well as potentials for their combination or interrelated use, (2) the user needs and design requirements for DI in the context of existing institutions as well as in the light of inter-related complex innovation systems and innovation policymaking areas, illustrated by a couple of "fictions".

In the present chapter we will try to translate the design requirements for DI and Improved Strategic Intelligence depicted in Chapter 3 into some tentative policy conclusions for European policies.

As already stated, there are at present many challenges to the European S&T system(s): the creation of new knowledge in science and technology has to be facilitated, the changing nature of technological innovation processes has to be reflected; the increasing number of actors in the innovation policy arena has to be recognised, and policies have to be performed more efficiently and effectively. All this calls for a re-orientation and re-organisation

- of research systems and their relationship with their economic, social and political environment (i.e. innovation systems)
- as well as of innovation policymaking procedures.

Thereby one must take into account that we live in a complex and changing world in which innovation and innovation policy formulation are undertaken by multiple actors (e.g. universities, applied research institutes, hospitals, research funding institutions, government agencies, multinational corporations, SMEs, consumer groups, NGOs, ...) at multiple levels (regional, national, transnational) with different interests (in terms of funding, regulations) and in the context of various value systems (scientific curiosity, value-for-money, ethical, ecological, ...).

In trying to improve strategic innovation policymaking, one does not, however, have to start from scratch. The existing body of experiences with technology foresight, technology assessment and S/T policy evaluation described above provides a basis for the development of an advanced innovation policy "planning" approach by trying to enhance, inter-link or even integrate the growing, but still dispersed experience in these three areas of intelligence.

Current practices in most countries as well as on the EU level, however, have evolved in an uneven, random and fragmented fashion. Individual exercises have rarely been inter-linked either conceptually or politically with one another. This lack of coherent linkages has led to under-utilisation of existing information, knowledge and capabilities in the process of S/T policy formulation. In consequence, this has become a major obstacle to attempts at coherent policy design and practices. For instance, the task set up in the Maastricht Treaty to arrive at a co-ordinated European science, research and technology policy (including regional, national, and European levels) so far has not been fed by the systematic use of intelligence tools.

There is a growing need and demand for "combined" or "linked" exercises, for example

- the demand for "formative" evaluations which include advice about future strategies based on associated foresight exercises (e.g. for the continuous and flexible adaptation of running initiatives as required by the 5th Framework Programme, FP5)
- technology assessment would increase the awareness of social issues in prospective technology outlooks
- evaluation of socio-economic impacts would be informed by technology assessment efforts, and vice versa.

There is much to be gained from customised exercises involving combinations and permutations of foresight, evaluation, technology assessment, for all can be seen as decision support tools which look back to see what we can learn from the past (evaluation), consider potential options for the future (foresight), and examine the implications of particular lines of action (technology assessment). There is also much to be gained from their systematic use and exploitation in multiple settings, with outputs accessible and distributed across actors, levels, environments etc., for instance in terms of

- matching of various national research and funding priorities
- distribution of responsibilities between regional, national, or European public or private actors
- public acceptability of science and technology and an increase in the transparency of related policy actions.

Against this background, there are several options to improve the current situation of policy formulation in the EU with regard to both the development of enhanced tools (ET) and the appropriate use of distributed intelligence (DI).

Starting point of our considerations on European S&T policy is the status-quo, which can roughly be described in the following way.

Starting with the status quo ...

In RTD policies, the main instrument of the EU has been on the Framework Programmes (FP), but the Commission also supports many other programmes which contain research-oriented activities or which contribute, albeit in varying degrees, to the European research and technology effort and to the formation of a European science and technology system. These include research activities carried out by Joint

Research Centres (JRC), a number of research-industry task forces, activities supported under the Structural Funds, initiatives related to the establishment and development of the European Information Society, as well as special programmes in the fields of environment, energy, international co-operation, education and training, and health and safety. If we go beyond science and technology policies or innovation policies per se, the European Union's competition policy, regional policy, employment and social policy, enterprise policy, industrial policy, economic and monetary policy, and education policy have many significant direct and indirect effects on scientific and technological development in Europe.

Nevertheless, in the near future the FP is most likely to remain the most significant single instrument of the Commission to promote scientific and technological development in Europe. Accordingly, the Directorate General Science, Research and Development of the European Commission (DG XII), has a key role to make use of distributed intelligence (DI) and to develop it as a system. An important part of such a development is to foster advanced approaches for better co-ordination of the FP and other science and technology related activities in the Commission.

A great number of institutions and initiatives providing information used in the policymaking process of S&T policy are already in place at the European level, or linked and contributing to activities on the European level, but many of them do not work very well and they are - up to now - not used in a coherent way to formulate European S&T policy strategies. The reasons for this sub-optimal functioning are as follows:

- lack of co-ordination between the various functions of the S&T system
- lack of co-operation between the different institutions, namely the various DGs and the Parliament
- lack of an appropriate assignment of tasks and roles for the involved institutions, be it on the EU level or national and regional levels
- lack of resources to carry out the assigned tasks sufficiently.

We will argue that there are some achievements to be reached within the existing institutional context of European S&T policies by:

- improving the methods and practices of TF, TA and EV ("enhanced tools")
- closing gaps in the patchwork of existing institutions and organisations using elements of DI
- improving the co-operation, the linkages between these institutions and easing access to the results of DI that already exist on various levels.

This can be exemplified with a look at the various existing institutions and the use they currently make of the tools of DI and the related infrastructure:

With regard to *foresight*, there has not been a fully-fledged TF exercise at the European level so far. TF has been undertaken in a number of individual member countries or even regions (see examples above). TF (and TA) related projects have also been carried out on the by the Institute for Prospective Technology Studies (IPTS) - an institute of the Union's Joint Research Centre (JRC). Some TF related exercises have also been carried out in the realm of individual sub-programmes of the FPs. Clearly, there is a need to avoid duplication of costly efforts and to relate existing activities more closely to each other, especially as the importance of achieving (or contributing) to the attainment of broader socio-economic goals has risen considerable in European S&T policies.

As has been stated above, a centralised large-scale European TF study might not be feasible and would be very costly. But building up a "brokering node" and an "enabling structure", that would help to design, monitor, take stock of and allow to access the results of TF exercises carried out by different actors (enterprises, regions, nations) is a task that could be accomplished in the short term.

Such an enabling function has to be centrally established, and could be fulfilled either by an existing European institution (e.g. IPTS) or could be delegated to a specialised unit. It could be assigned the roles of information gathering and synthesizing the results of existing TF studies. To this purpose it should be equipped with sufficient resources. Networks of experts/specialised institutions (like European Technology Assessment Network, ETAN, and European Science & Technology Observatory, ESTO) would in principle be a good framework for a translation of the TF results into policy recommendations like advising the Commission regarding the utilisation of these results and setting topics for TF exercises at national and programme levels. For this end, their functioning would have to be improved, including a better accessability.

As regards *technology assessment* a considerable numbers of activities exist on the level of the individual member states (see again the examples given above) alongside existing but weak institutions at the European level (namely European Parliamentary Technology Assessment, EPTA). As in the case of TF, an important task at the European level would be to secure an infrastructure for the brokering of results (e.g. a "directory") but also to facilitate direct contacts between the actors (e.g. in the form of "consensus conferences"). Again, there is the need for a "central node" in the circulation of information and in facilitating inter-linkages between the actors.

In the case of TA, the European Parliament has a strong role to play – given the above mentioned increased importance of broader socio-economic objectives in the definition of European RTD priorities. However, the role, tasks and resources of a TA institution serving the European Parliament (EP) should be overhauled to be able to cope with these tasks. Rather than carrying out TA studies of its own (which would anyway be of limited scope given the small amount of resources currently available to EPTA), it should focus on organising the debate on technological progress and on potential choices for society. In particular, it should focus on improving an adoption capacity of the EP by digesting and synthesizing the numerous TA studies carried out in the various EU countries. Here, the role of the EP could be strengthened: based on the outcome of TA exercises it could have an active role in initiating programmes on the bases of TA exercises or to reject or modify individual programmes brought forward by the Commission.

Evaluation activities have a recognised role and status in the RTD policies of the European Union. They are institutionally established both at the level of the projects as well as the evaluation of the programmes (Framework Programmes and Sub-Programmes, by independent evaluation panels). Nevertheless, EV is confronted with huge challenges as well - both regarding the methodology and scope of the evaluations as well as the institutional settings for it.

The DG XII has been rather occupied with organising processes of project evaluations (which is rather project appraisal) than with strategic evaluation. A shift is needed for the development of methods and approaches to evaluate broader socio-economic impacts of the FP and other science and technology initiatives. As in the fields of TF and TA, an important task of the Commission is to mobilize a pool of expertise available in the various countries on which one could dwell for the individual evaluation exercises. In addition, the role of the Commission should be to encourage the development of methodologies, to help collaboration, to secure the dissemination of national and European experiences and to assist in "quality assurance" of the evaluations (e.g. by certifying procedures).

Alongside the improvement of the individual tools and their institutional infrastructure of DI, there is also a need to interrelate these activities more closely than in the past. In the realm of the Commission, there have been attempts to arrive at such linkages: there are activities cutting across the delineations of the fields of distributed intelligence, like ETAN and European Innovation Monitoring System (EIMS), which incorporate elements of both TF, TA and EV. They were meant (1) to provide a platform for dialogue, at the European level, between researchers and policymakers on key-technology-society issues and (2) to facilitate dissemination and exploitation of RTD results, technology transfer and innovation. Because of the borderlines between directorates, results of these studies are not very much used in the planning and decisionmaking related to the Framework Programmes. Thus, the present activities do not really live up to the design requirements of DI sketched above.

As has become clear from the elaboration above, even in a "status-quo scenario", that is, given the set of existing institutions carrying out the functions of distributed intelligence for innovation policy, there is room for considerable improvement of the functioning along the following principles:

- Better co-ordination of TF, TA, EV along the policy-cycle between the DGs. The role of DG XII as a mediator between other parts of the Commission and national innovation policy actors could be strengthened.
- Better co-operation between the Commission and the EP in general and in TA in particular. A stronger role for the EP, especially with regard to TA.
- Better assignment of tasks of the respective institutions, with a focus of EU institutions on information gathering, synthesizing and preparation of policy decisions rather than carrying out the research tasks themselves.

- The development and full use of the expertise of national institutions through commissioning, joint projects etc. is a necessary basis for any EU exercise in TF, TA and EV. Information exchange and regular mutual staff exchange between the different communities could be organised on the European level (e.g. in the form of (bi-)annual conferences on TF, TA, and EV).
- The development of interfaces between science and technology actors and the general public (e.g. as the Internetbased "Futur-Prozess", recently launched in Germany extending the Foresight experiences of the 1990s).

... to Improved Strategic Intelligence for policymaking in multi-actor/multi-level systems

Since innovation policy is increasingly a matter of networking between heterogeneous (organised) actors instead of top-down decision-making and implementation policy decisions are frequently negotiated in multi-level/multi-actor arenas and related actor networks. Negotiating actors pursue different - partly contradicting - interests, represent different stakeholders perspectives, construct different perceptions of ”reality”, refer to diverging institutional ”frames”. This scenario assumes a co-evolution of regional, national and European innovation policy arenas towards an aggregation in multi-level, multi-actor systems. In this setting new linkages and distribution of tasks between the European Parliament and national parliaments would be established, and the Commission (or similar bodies) would concentrate rather on the "mediation" of innovation policy initiatives in multi-level governance system. One important source of mediation competencies is the disposal of Strategic Intelligence.

Beyond this mediation function European innovation policies might put an increased emphasis on mission-orientation towards societal problems (while most diffusion-oriented programmes would remain in the domain of the member states), a tendency that has already been emerging with the FP5. In the longer run, new mission-oriented programmes based on comprehensive considerations of needs and opportunities as well as impacts could be launched to complement current generic programmes and other schemes. This would entail more horizontal activities, and hence different forms of organisation of these activities - e.g. in the form of the "task forces". Therefore, the above mentioned principles apply here as well: there would be a need for better co-operation and interaction between DGs dealing with science, technology and innovation policies and in addition to top-down instruments, bottom-up initiatives must be generated and existing ones supported.

As mentioned above, this was just a sketch to indicate that our elaboration on the design requirements for DI can already be translated into concrete – though tentative – policy recommendations in the short term, that is, applied to the current status of innovation policy formulation in the European Union. We believe that they would be even more applicable to a European Union in which policy competences and procedures are more adopted to the current rapid developments in science, technology and societies than is the case at present. We have tried to highlight how such mechanisms might look like in the scenarios of alternative futures in Chapter 3.

In essence ...

To sum up briefly, in this report we have argued for a new approach which we have called a system of Distributed Intelligence (DI). In particular, we have suggested the development of tools which can be used in different combinations to enhance Strategic Intelligence inputs into policymaking, and access to, and exploitation of Strategic Intelligence in 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. If we manage to develop and implement a new DI infrastructure, then innovation policies could become more efficient, more relevant, and more democratic.

In the DI, the architecture refers to actors, levels, and sources of demand supply. In particular, the role of an intermediary area of spaces and competencies, which guides and enables the supply of Strategic Intelligence, is becoming central.

There is no single "correct" configuration of tools, procedures, institutions and structures which 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" organisation have become more important as policy arenas. Moreover, there is a growing need for new configurations which link up private and public actors and promote their interaction. By private actors we do not mean only companies, but as well representatives of many other stakeholders (professional associations, consumer organisations, environmental organisations etc.).

Since the intelligence needs of different actors are highly specific and "localised", these needs can only be satisfied via highly customised intelligence gathering and problem-solving exercises – all differing radically from one organisational and spatial setting to another.

A world of distributed policymaking and DI related to it takes into account the changing conditions of innovation processes, the political requirements for a democratic choice of future technologies, and a need to limit public expenditure linked to decisionmaking processes. Distribution means leaning on bottom-up processes, but to be effective and trustworthy, standards of quality and quality assurance systems need to be developed. In addition, of crucial importance will be central networking nodes, which facilitate horizontal linkages and the circulation of knowledge between different policy arenas and levels.