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## Preface

This volume on Prospective Technology Studies includes papers from two sources. On the one side it is based on a workshop that was organized in the framework of an *International Forum on Sustainable Technological Development*. It is worth while to say some words about the origin of the Forum. Two universities, Florida Institute of Technology (Florida Tech) located in Melbourne, Florida, and the Budapest University of Technology and Economics (BME) have cooperated beginning in September 2001, supported by a U.S. State Department CUAP Grant for 3 years in the field of environmental protection and environmentally sustainable technologies (environmental studies). The then existing Department of Innovation Studies and History of Technology at BME also recalled its long period of cooperation with the Institute of Technology Assessment and Systems Research (ITAS) at the (former) Research Center of Karlsruhe (Forschungszentrum Karlsruhe – FZK), now the Karlsruhe Institute of Technology (KIT). When BME and Florida Tech personnel met, in June 2002, in the beautiful small Hungarian town of Eger to conduct a "Sustainable Tourismus" workshop, Professors Gerhard Banse and Imre Hronszky discussed with Professor Gordon Nelson (Florida Tech) an idea to initiate and develop a forum devoted to assessing how technological development can be made sustainable. It was decided that these institutions would try to develop and realize an annual international workshop devoted to this goal, to realise one in Hungary (or later in Germany) and then in the USA, alternating.

These workshops have been realised and the selected materials of earlier workshops were consecutively published. (You will find a list of the books at the end of this introduction.) For several reasons the publication of the selected presentations of the workshop in Budapest at the end of 2007 could not be published until now. Later it seemed worthwhile to unify these materials with selected presentations from the symposium on *History of Prospective Technology Studies, in the framework of the XXIII International Congress of History of Science and Technology,* Budapest, July 2009. That symposium was actually organized by nearly the same persons who established the Forum. Presentations from the symposium in Budapest were not only selected but some additional articles are also included. The reason is that notwithstanding good intention, not all of the authors in the current volume could come to Budapest in July 2009 to give their presentation at the World Congress. Thus, this volume entails the updated materials of these two programmes, in 2007 and 2009.

Two more remarks are in order. One is in relation to the symposium at the World Congress of Historians. The Historical Division of the Union of History and Philosophy of Science (IUHPS), the Division of History of Science, had here the first congress with a changed name. The name had been changed into Division of History of Science and Technology (DHST) to express the changing understanding that history of science and technology should be seen as mostly overlapping over a long part of history. Getting through with organizing a symposium on history of prospective technology studies belonged to the changed understanding. It expresses that, in an up-to-date historical approach, it is unavoidable to integrate history of the reflexive dimension too. This bring us to the second remark. To help technology policy to be more knowledge based a series of different policy analysing disciplines emerged and merged in the last half century. The name prospective technology studies expresses a holistic and transdisciplinary new approach in which different disciplinary perspectives are utilised to help feature and realise improved knowledge of technology policy relevance.

Two more workshops have already been realised in the frame of the Forum in between. One workshop was realised in Berlin in June 2010, another just recently in Melbourne, Florida, March 2011. Their selected presentations are under editorial work and will be published soon.

Budapest/Karlsruhe/Melbourne, April 2011

Gerhard Banse
Armin Grunwald
Imre Hronszky
Gordon Nelson

## Published materials of the earlier workshops (in chronological order)

Nelson, G.; Hronszky, I. (eds.): How Science Can Support Environmental Protection? Florida tech-BME Partnership Programme Yearbook 2003. Budapest 2003

Nelson, G.; Hronszky, I. (eds.): Science Supporting Environmental Protection. Budapest 2004

Banse, G.; Hronszky, I.; Nelson, G. (eds.): Rationality in an Uncertain World. Berlin 2005

Nelson, G.; Hronszky, I. (eds.): Environmental Studies. Implications for Sustainability. Budapest 2005

Banse, G.; Grunwald, A.; Hronszky, I.; Nelson, G. (eds.): Assessing Societal Implications of Converging Technological Development. Berlin 2007

Hronszky, I.; Nelson, G. (eds.): An International Forum on Sustainability. Budapest 2008

Nelson, G. L.; Hronszky, I. (eds.): Sustainability 2009: The Next Horizon. Melville, NY 2009 (AIP Conference Proceedings, Vol. 1157)

# Part I: Foresight, Roadmapping, and Governance

# Governing Policy Processes and Foresight. Potential Contributions and Inherent Tensions

*Attila Havas*

## 1 Introduction

The increasing number of foresight programmes suggests that it can be a useful policy tool in rather different national innovation systems. Emerging economies – faced with a number of similar challenges when trying to find their new role in changing international settings, while still characterised by their own distinct level of socio-economic development, set of institutions, behavioural norms and decision-making culture – can also benefit significantly from conducting foresight programmes.

This paper is aimed at discussing the potential and actual role of foresight in governing policy processes, especially in the context of emerging economies in Central and Eastern Europe (CEE). In doing so, first the theoretical underpinnings of this analysis is summarised briefly. Then the rationale of conducting foresight is presented: what policy challenges can be tackled by applying foresight? It is followed by a discussion of a new typology of foresight programmes, distinguishing the ones with an S&T, techno-economic or societal / socio-economic focus. The concluding section summarises the major lessons, but also presents some policy and methodological dilemmas.

## 2 Theoretical Framework

Foresight programmes do not have a single, all-encompassing theory to support them, and thus they rely on a range of – somewhat overlapping – theories and methods, including (1) evolutionary economics of innovation; (2) sociology of science and technology; (3) actor-network theories; (4) political sciences analyses of policy processes; (5) communication, co-operation, and participation theories; (6) decision-preparatory and future-oriented methods, techniques. This list is far from exhaustive, and most likely disciples of these theories would change the grouping, the order of their own discipline or even the wording used here. That might be an interesting discussion in its own right, indeed, for theoretical purposes. Yet, the intention here is just to indicate the "eclectic" – and thus complex – nature of foresight programmes, rather than attempting to provide a meticulous, comprehensive treatise of these issues.

This section is concerned with evolutionary economics of innovation[1] because this theory provides useful observations to appreciate the relevance of foresight programs from different angles. First, foresight (programs), future, change, innovation and uncertainty are closely interrelated notions – and some of these are the underlying terms of evolutionary economics of innovation. Second, foresight programs are important policy tools, and thus the nature of policy formation processes and the policy rationale of foresight programmes should be clearly understood (further explored in Section 3).

### 2.1 The Process of Innovation and Economic Theories

Obviously, no comprehensive overview on evolutionary economics of innovation can be provided here: only the main features are highlighted.

Innovation, defined as "the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organisational set-ups" (Dosi 1988a, p. 222), leads to variety (diversity), and competition. The latter one, in turn, both conducive to innovation and induced by innovation, selects among firms (or organisations, more generally).

In spite of the apparent similarity with biological processes, one should not mistakenly equate evolutionary economics with evolutionary biology. Christopher Freeman highlights two fundamental differences (cf.

1 See, e.g., Dodgson/Bessant 1996; Dodgson/Rothwell 1994; Dosi 1988b; Dosi et al. 1988, 1994; Edquist 1997; Ergas 1987; Fagerberg et al. 2005; Freeman 1994a; Freeman/Soete 1997; Lundvall 1992; Lundvall/Borrás 1999; Lundvall et al. 2002; Metcalfe/Georghiou 1998; Nelson 1993, 1995; Nelson/Winter 1982; Niosi 2002; OECD 1992, 1997, 1998, 2001; Smith 1997, 2002.

Freeman 1994b). First, selection is at least partly conscious in the innovation process as decision-makers can choose between various "mutations" (that is, new products, processes and organisational forms). Moreover, their expectations, hopes, plans and values also shape the "evolution" of these "mutations". Ethical and social considerations, therefore, play an increasingly important role in the innovation process, notably in the development and utilisation of nuclear energy and biotechnology, as opposed to the process of biological evolution. Second, selection is taking place at a number of levels in the course of competition: among products, firms (organisations), sectors, regions, countries and socio-economic systems. There are some autonomous rules and laws of the selection process at these different levels. Strong interrelations and interdependencies, however, can also be observed. Technological innovations are shaping both their natural and socio-economic environment, while the success of innovations strongly depends on their environment, including the quantity, quality and distribution of accumulated capital in the form of production equipment, roads, railways, communications networks, bridges, etc., as well as policies, attitudes and norms, that is, institutions in short.

While rational agents in the models of neo-classical economics can optimise via calculating risks and taking appropriate actions, "innovation involves a fundamental element of uncertainty, which is not simply the lack of all the relevant information about the occurrence of known events, but more fundamentally, entails also (a) the existence of techno-economic problems whose solution procedures are unknown, and (b) the impossibility of precisely tracing consequences to actions" (Dosi 1988a, p. 222; emphasis by me, A.H.). Thus, the notions of optimisation or maximisation become meaningless.

Another important implication of uncertainty concerns the scientific and policy relevance of forecasting, based on the extrapolation of (supposedly) known trends. The space of events, in which forecasting can be meaningful is strictly limited: the only certain – and thus easily predictable – outcome of innovative activities is that most of the underlying technological and business trends can change quite radically even in the space of 10-15 years.[2] From a policy perspective, therefore, new methods are required, which can take into account uncertainty during a decision-preparatory process. Foresight is a prominent one from this point of view, for two reasons. First, it is capable of dealing with uncertainty by devising alternative (qualitatively, or fundamentally different) "futures" (visions of future, future states or scenarios). Indeed, it is a distinctive feature of foresight to consider alternative futures. Second, foresight processes can reduce uncertainty, too, because participants can align their endeavours once they arrive at a shared vision. To this effect, however, it is a necessary condition to involve the major stakeholders, who can significantly influence the underlying trends by shaping the strategies or policies of their respective organisations (government agencies, businesses, research organisations, NGOs, unions, etc. – depending on the issues in question, as well as the political and decision-making culture of the "entity" conducting a foresight programme: international organisations or regions, nation states, sub-national regions, business associations, groups or individual firms, cities, etc.).

As opposed to the "time-less" world of neo-classical economics, "history counts: past technological achievements influence future achievements via the specificity of knowledge that they entail, the development of specific infrastructures, the emergence of various sorts of increasing returns and non-convexities in the notional set of technological options" (Dosi 1992, p. 183). In other words, technological change is a cumulative, path-dependent process, and hence increasing returns are at least as important as diminishing returns. Closely related notions, also in the heart of evolutionary thinking, are learning by doing, using, interacting (cf. Freeman 1994a) and comparing (cf. Lundvall/Tomlinson 2002).

Mainstream economics is mainly concerned with the availability of information (or information asymmetries in its jargon). Both theoretical and empirical studies reflect, however, the growing recognition that the success of firms – regions and nations – depends on their accumulated knowledge, both codified and tacit,[3] and skills, as well as learning capabilities. Information can be simply bought, and hence mainstream economics is comfortable with it. Knowledge – and a fortiori, the types of knowledge required for innovation – on the contrary, cannot be mistaken with goods that can be purchased and used instantaneously; one has to

[2] Obviously, there are certain trends, e.g. demographic ones, which are not directly influenced by innovative activities, on the one hand, and their "stability" (predictability) extends to a much longer time horizon (in this case around 40-50 years), on the other. Also, the pace and intensity of innovative activities – and hence their impacts on major technological and business trends – vary significantly across time (different historical periods) and countries (socio-economic systems).

[3] For a brief, but highly informative, discussion of codified and tacit knowledge, and the policy relevance of this distinction, cf. Lundvall/Borrás 1999 (especially pp. 31-33), as well as the literature they refer to.

go through a learning process to acquire knowledge and skills.[4] It obviously takes time and involves the process and costs of trial and error. Thus, the uncertain, cumulative and path-dependent nature of innovation is reinforced.

An important aspect of learning should be underlined here, namely its level. Some analysts and policy-makers highlight network re-alignment and research, technological development and innovation (RTDI) policy updating as key foresight benefits – which are crucial impacts, depending on the "focus" of a given foresight programme (see Section 4.2.2 on "focus") Case studies and anecdotal evidence clearly suggest, however, that there are often overlooked or "hidden" benefits relating to learning at the level of individuals and communities. Actually, it is almost a commonplace among practitioners to refer to foresight as a learning process, although quite often they mean methodological learning. In any case, it might be a fruitful idea to make a clear distinction among the different levels of learning, i.e. not to focus exclusively at the "macro" level, but give more prominence to individual and community learning when devising or evaluating foresight programmes.

Cumulativeness, path-dependency and learning lead to heterogeneity among firms and other organisations. Moreover, sectoral characteristics of the innovation process should also be taken into account while devising strategy or policy.[5]

A vast body of empirical literature has also clearly shown that innovators are not lonely scientists. While some path-breaking scientific or technological ideas might come indeed from individuals, successful innovations can only be generated by a close collaboration of different organisations such as: university departments, government and/or contract research labs, firms and specialised service-providers. Forms of their co-operation can also be varied widely from informal communications through highly formalised R&D contracts to alliances and joint ventures.[6] Thus, conscious network-building efforts of foresight programmes are crucial, indeed – as well as their unintended impacts on networking (in case of the lack of explicit objectives to strengthen existing networks, facilitate the formation of new ones, and more generally, foster communication and co-operation; see Section 4.2 on different types of foresight programmes).

## 2.2 Implications for RTDI Policies

Evolutionary account of the innovation process offers some sobering lessons: in a world of uncertainty, policy cannot bring about the optimum either. The policy-maker is not "a perfectly informed social planner correcting imperfect market signals to guide private decisions toward more desirable outcomes". (Metcalfe/Georghiou 1998, p. 94) Of course, this conclusion is not easy to accept, especially for those trained in the paradigm of rationality, maximisation and optimisation: "For obvious reasons, many economists prefer models that provide precise policy recommendations, even in situations in which the models are inapplicable to the world of our existence. Our own view is that, rather than using neo-classical models that give precise answers that do not apply to situations in which technology is evolving endogenously, it is better to face the reality that there is no optimal policy with respect to technological change" (Lipsey/Carlaw 1998, p. 48).

Variety, selection and uncertainty also have repercussions on the very nature of policy and strategy formation, and thus decision-makers – either devising public policies or strategies for firms or RTDI organisations – should take into account these features. The relevant and potentially successful policies and strategies adaptive ones, relying on, and learning from, feedback from the selection process to the development of further variation (cf. Metcalfe/Georghiou 1998). In other words, policy and strategy formation is increasingly becoming a learning process (cf. Lundvall/Borrás 1999; Teubal 1998). This notion underlines the importance of foresight programmes: more "robust" policies can be devised when (1) alternative futures are

4 Borrowing a sparkling parable of Giovanni Dosi, although there are market conditions of access to information e.g. there is a market for textbooks and economic conditions of access to higher education (the level of tuition fees, the availability or scarcity of grants for students), "in any proper sense of the word, getting a PhD is not simply acquiring information, and it is even less true to say that there is a market for PhDs" (Dosi 1988b, p. 1130).

5 A seminal taxonomy, developed in Pavitt 1984, identifies supplier-dominated sectors, specialised suppliers, scale-intensive and science-based sectors.

6 Freeman provided a thorough literature survey on the importance of networks and the innovation system approach (cf. Freeman 1991, 1994a, 1995); cf. also Edquist 1997; Lundvall 1992; Lundvall/Borrás 1999; Nelson 1993; OECD 2001; Tidd et al. 1997; cf. as well as the October 1991 (Vol. 20, No. 5) and February 2002 (Vol. 31, No. 2) issues of "Research Policy" (respectively).

considered, and (2) participants with different background are actively involved in a decision-preparatory process, and thus bringing wide-ranging accumulated knowledge, experience, aspirations, and ideas in.[7]

Certain types of foresight programmes (see Section 4.2) can take into account these broader issues, as opposed to focussing narrowly on advancing scientific research in specific fields of enquiry or developing particular technologies. It, therefore, can be a crucial policy tool, especially if it is explicitly aimed at strengthening – regional, sectoral, national or trans-border – innovation systems. (The network-building aspects of foresight programmes have already been discussed in Section 2.1.)

Another major policy implication of this analytical framework is that conscious, co-ordinated policy efforts are needed to promote knowledge-intensive activities in all sectors, with the explicit goal of upgrading firms' capabilities, and thus improving their overall competitiveness. In other words, despite of the widespread believes in the "magic" and automatic impacts of the so-called high-tech industries on economic growth, policy-makers should be aware of the importance of knowledge-content in the low- and medium-technology (LMT) industries, too.[8]

An EC document also draws the attention of policy-makers to this conclusion in a balanced, succinct way: "The EIS [European Innovation Scoreboard – A.H.] has been designed with a strong focus on innovation in high-tech sectors. Although these sectors are very important engines of technological innovation, they are only a relatively small part of the economy as measured in their contribution to GDP and total employment. The larger share of low and medium-tech sectors in the economy and the fact that these sectors are important users of new technologies merits a closer look at their innovation performance. This could help national policy makers with focusing their innovation strategies on existing strength and overcome areas of weakness" (EC 2003, p. 20).

Foresight programmes, therefore, need – and should – not be confined to the narrow field of high-tech sectors (or "advanced" S&T topics).

## 2.3 Foresight, Innovation and RTDI Policies

To avoid some potential misinterpretation, finally it should be stressed that opting for this theoretical framework does not mean that foresight should be understood as a vehicle to support narrowly defined (technological) innovation processes or RTDI policies (see more on the policy rationale of the different types of foresight programmes in Section 4.2.). A narrow understanding would exclude, for example a foresight programme to create visions for cancer treatment.[9] Two aspects need clarification: (1) the relationships between foresight and innovation; and (2) the links between foresight programmes, RTDI and other policies.

First, it might be useful to repeat that innovation should be understood as the introduction (practical application) of new or significantly modified products, production processes, services, as well as organisational and managerial practices (techniques). Thus, visions for new cancer treatments are about innovation, too, following this widely accepted broad definition: we should envisage not only new medicines (product innovations), but also new ways to "provide services" in the health care system (service, process, organisational and managerial innovations).[10] Moreover, visions generated by a foresight process would certainly encompass prevention, too (concerning diet, drinking and smoking habits, doing sports, reducing stress, etc.). This is also a new approach in terms of addressing an issue, i.e. a policy and organisational innovation at a social level – requiring new habits at an individual level. Also, new cancer treatments are likely to contribute to socio-economic development in several ways. To mention just two of them here: (1) in a narrow economic sense they can be cheaper or more efficient than the old ones, i.e. more patients can be cured faster (losing less time, which can be used for "productive" purposes) and at lower costs; (2) more broadly,

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7 Country reports on national innovation policies at http://www.proinno-europe.eu.

8 Just to prevent some potential misinterpretations, it should be stressed that this paper is not intended, of course, to advocate a "low-tech development path" for emerging economies, or to "relegate" them to the second or third "technology division" with low competitiveness, and hence low living standards.

9 These observations are prompted by a question of Göran Pagels-Fick: "Could we envisage a foresight programme to create visions for cancer treatment practices?" (comment on an earlier draft of this paper).

10 This is a generally accepted definition of innovation by international organisations, such as the OECD and EU, shared by researchers and policy-makers, too. Quite often, however, other people, e.g. journalists and politicians still use the term in its narrow sense, i.e. they only refer to technological innovations.

the quality of life is improved when less people suffer from cancer, and less people should fear of cancer, due to better treatments.

Second, so far it has only been emphasised that foresight is an important innovation policy tool. It should be added that it could be useful in other policy domains, too. The above example clearly shows that health policies also need to deal with – and promote – various types of innovations.[11]

In sum, the subject itself is not a decisive factor for being "qualified" as a foresight programme; what matters is to meet the three criteria set in Section 4.1.

# 3 Policy Challenges: Why to Conduct Foresight

Foresight (or the use of some other methods to assist future-oriented thinking) offers a number of advantages for decision-makers: it is a tool to (1) recognise and emphasise the possibility of different future*s* (or future states), as opposed to the assumption that there is an already given, pre-determined future, and hence the opportunity of shaping our futures; (2) enhance flexibility in policy making and implementation; and (3) broaden perspectives, encourage thinking outside the box ("think of the unthinkable"). A number of major trends affect all countries and most areas of policy-making, thus a *new culture of future-oriented thinking* is needed.

Foresight programmes have been widely applied, especially since the 1990s. As a growing body of literature analyses this surge, the major factors explaining the diffusion of foresight can be summarised in a telegraphic style:

- Globalisation, coupled with sweeping technological and organisational changes, as well as the ever-increasing importance of learning capabilities and application of knowledge have significantly altered the "rules of the game". Thus, policy-makers have to take on new responsibilities (as well as dropping some previous ones), while firms must find new strategies to remain, or become, competitive in this new environment.
- Given the above factors our future cannot be predicted by any sophisticated model. Planning or forecasting of our future becomes more and more ridiculed in light of rapid and fundamental changes. History also teaches us valuable lessons about the (im)possibilities of planning and predicting the future. Therefore, flexibility, open minds for and awareness of possible future*s* are inevitable. Diversity is a key word: diversity in scope (in terms of possible futures, differing analyses, etc), as well as diversity in solutions or policy options.
- Decision-makers face *complex* challenges: socio-economic and technological factors interact in defining issues of strategic importance, e.g.
  - education and life-long learning (new demands on education systems; new, mainly ICT-based tools and methods for teaching and learning; the growing need for interaction and co-operation with businesses);
  - environmental issues;
  - quality of life (health, education, demographic changes, especially the growing share and special needs of elderly people, living and working environment, social conflicts, crime prevention, etc.);
  - competitiveness (at national and EU-level for attracting talents and capital, at firm level maintaining and increasing market shares nationally and internationally, etc.);
  - regional disparities.
- Most policy problems no longer have "self-evident" solutions. Governments are forced to make use of "evidence-based policies", policies based on knowledge/ insight into what works and what does not.
- Policy-makers have to learn to cope with growing complexity and uncertainty of policy issues themselves. Thus, the precautionary principle is of a growing significance.
- New skills and behaviour are required (e.g. problem-solving, communication and co-operation skills in multidisciplinary, multicultural teams meeting more often only "virtually", as well as creativity) if individuals or organisations are to prosper in this new setting. This, in turn, creates new demands on the education and training system (see above).

[11] Ian Miles is among the pioneers to stress the importance of innovation in service sectors, and he has also written extensively on the role of innovation in services provided by the state, and thus on the need to devise appropriate policies in these fields to promote innovations.

- Clusters, networks (business – academia, business – business, both at national, international levels) and other forms of co-operation have become a key factor in creating, diffusing and exploiting knowledge and new technologies, and therefore in satisfying social needs and achieving economic success.
- There is a widening gap between the speed of technological changes and the ability to devise appropriate policies (which requires a sound understanding of the underlying causes and mechanisms at work).
- Given the growing political and economic pressures, governments try hard to balance their budgets: when cutting taxes, they need to reduce public spending relative to GDP. In the meantime accountability – why to spend taxpayers' money, on what – has become even more important in democratic societies. Public R&D expenditures are also subjected to these demands.
- Policy-makers also have to deal with intensifying social concerns about new technologies (mainly ethical and safety concerns in the case of bio- and nano- or nuclear technologies, and fears of unemployment and social exclusion caused by the rapid diffusion of new technologies in general).
- Even the credibility of science is somewhat fading. Scientific research no longer stands for "true" in itself. The "objectiveness" of policies based on scientific research is questioned (by citizens, interest groups, etc.) as scientists themselves are known to have different opinions and come to different conclusions on the same issue.

Besides the above trends, there are other specific, policy-relevant methodological reasons to apply foresight.

*First*, it can offer vital input for "quantum leaps" in policy-making in various domains. Usually policies evolve in a piecemeal way, in incremental, small steps. From time to time, however, a more fundamental rethinking of current policies is needed. In other words, policy-makers occasionally need to ask if current policies can be continued: do they react to signs of changes, block or accommodate future developments? The parable of the boiling frog illustrates this point "vividly": put a frog in a cooking pot with cold water, and start heating the water. The frog will not jump out, because it does not alerted by the slowly rising temperature. It will boil alive.

*Second*, foresight can also help in picking up *weak signals*: weak but very important signals that a fundamental re-assessment and re-alignment of current policies are needed. In other words, foresight can serve as a crucial part of an *early warning* system, and it can be seen as an instrument for an adaptive, "learning society".

In sum, participative, transparent, forward-looking methods are needed when decision-makers are trying to find solutions for the above challenges. Foresight – as a systematic, participatory process, collecting future intelligence and building medium-to-long-term visions, aimed at influencing present-day decisions and mobilising joint actions (cf. EC 2002) – offers an essential tool for this endeavour. It helps in making choices in an ever more complex situation by discussing alternative options, bringing together different communities with their complementary knowledge and experience. In doing so, and discussing the various visions with a wide range of stakeholders, it also leads to a more transparent decision-making process, and hence provides a way to obtain public support. The foresight process can reduce uncertainty, too, because participants can align their endeavours once they arrive at shared visions. Many governments have already realised the importance of foresight activities, and thus this relatively new, and innovative, policy tool is spreading across continents.[12]

The above general considerations apply in catching-up countries in the CEE region, too. Quite a few pressures – especially the need to change attitudes and norms, develop new skills, facilitate co-operation, balance budgets – are even stronger than in the case of advanced countries. Moreover, most of these countries also have to cope with additional challenges: the necessity to find new markets; fragile international competitiveness; relatively poor quality of life; and brain drain. These all point to the need to devise a sound,

[12] For a detailed and systematic analysis of the rationale for foresight and description of national exercises, see Aichholzer 2001; Barré 2001, 2002; Blind et al. 1999; Cagnin et al. 2008; Cassingena Harper/Georghiou 2005; Coates 1985; Cuhls 2003; Cuhls et al. 2002; DACCST 1999; EC 2002; FOREN 2001; Gavigan/Cahill 1997; Georghiou 1996, 2002; Georghiou/Keenan 2006; Georghiou et al. 2008; Grupp 1996; Grupp/Linstone 1999; Havas 2003a, 2003b; Havas/Keenan 2008; Klusacek 2004; Kuwahara 1996, 1999, 2004; Martin 1996; Martin/Irvine 1989; Martin/Jonston 1999; OST 1998; Renn 2002; Saritas et al. 2007; Shin 1998, 2004; as well as special issues of "Futures" (Vol. 43, No. 3), "Journal of Forecasting" (Vol. 22, No. 2-3); "Technology Analysis & Strategic Management" (Vol. 20, No. 3; Vol. 21, No. 8), "Technology Forecasting and Social Change" (Vol. 72, No. 9; Vol. 75, No. 4; Vol. 76, No. 9; Vol. 77, No. 9) "Science and Public Policy" (Vol. 37, No. 1).

appropriate innovation policy, and even more importantly, to strengthen their respective systems of innovation. Foresight can be an effective tool to embark upon these interrelated issues, too, if used deliberately in this broader context.

Foresight can also contribute to tackle yet another challenge of emerging economies: most of them are struggling with “burning” short-term issues – such as pressures on various public services, e.g. health care, education, pensions and thus severe budget deficit; imbalances in current accounts and foreign trade; unemployment; etc. – while faced with a compelling need for fundamental organisational and institutional changes. In other words, short- and long-term issues compete for various resources: capabilities (intellectual resources for problem-solving); attention of politicians and policy-makers who decide on the allocation of financial funds; and attention of opinion-leaders who can set the agenda (and thus influence discussions and decisions on the allocation of funds). These intellectual and financial resources are always limited, thus choices have to be made. A thorough, well-designed foresight process can help identify priorities, also in terms of striking a balance between short- and long-term issues.

Further, foresight can offer additional “process benefits” in the CEE region. By debating the various strengths, weaknesses, threats and opportunities of a country posed by the catching-up process, and the role of universities and research institutes in replying to those challenges, the process itself is likely to contribute to realign the S&T system (including the higher education sector) to the new situation. An intense, high profile discussion – in other words, a wide consultation process involving the major stakeholders – can also be used as a means to raise the profile of S&T and innovation issues in politics and formulating economic policies (cf. Georghoiu 2002).

To conclude, foresight should not be conducted for its own sake – just because it is becoming “fashionable” throughout the world, and currently being promoted by international organisations. On the contrary, there should be a strong link between foresight, decision preparation and policy-making: foresight should be used as a policy tool to address major socio-economic and political challenges. It is not a panacea, however; it cannot solve all the problems listed above, and cannot solve any of them just on its own. Obviously, other methods and tools are also required, as well as an assiduous implementation of the strategies devised either at national, regional, sector or firm level.

# 4 A Typology of Foresight Programmes

## 4.1 Locating Foresight Programmes among Future-oriented Analyses

Decision-makers, experts, and laymen in different historical periods and in different socio-economic systems shared at least one desire: to know their future in advance or even to influence it for their advantage. They used very different approaches and methods from spiritual / religious ones to scientific investigations and various modes of planning.[13] Without going into details here, it is worth recalling some of the major methods / approaches in order to locate – and distinguish – foresight programmes:

- visionary thinking (in ancient times by prophets, more recently mainly by consultants);
- forecasting (at different levels, using different methods, e.g. trend analysis, extrapolation);
- futures studies (for academic purposes);
- prospective analyses (for business or policy purposes, e.g. [technology] roadmapping, list of critical/ strategic/ key technologies);
- strategy formation (at firm, sectoral, regional or national levels);
- scenario planning (at a firm level; cf., e.g., Godet 2001);
- indicative national planning;
- central planning (at a national level);
- foresight programmes.[14]

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[13] Hence, a special chapter of the history of mankind can be devoted to these different attitudes, methods and approaches towards the future.

[14] The term “foresight programme(s)” is used throughout this paper as an attempt to distinguish individual (personal) foresight and “collective” foresight programmes, i.e. the ones launched (and sponsored) by an organisation (or several ones), and involving a number participants. Moreover, an increasing number of papers, written by researchers working in the field of future studies, “foresight” is used as a new label for their work (although still fol-

Obviously, the above approaches have a number of common characteristics. All of them (a) deal with the future(s) in one way or another; (b) collect and analyse various pieces of information, and (c) can apply a wide range of methods, mainly scientific ones. Three key features can be used to differentiate the above approaches, and thus distinguish foresight programmes from other methods. These approaches can

- be action-oriented vs. "contemplative" (passive);
- be participatory vs. non-participatory;
- consider alternative futures vs. a single future state (already "set" by external forces).

Action-oriented endeavours aim at shaping / influencing / acting upon the future,[15] while passive ones are "contemplating" about it (e.g. "pure" futurologist studies, without any policy implications). In other words, the latter ones merely try to develop a better-informed anticipation of the future, e.g. for being better prepared by having more precise information.

Participatory future-oriented programmes/ projects meet all the three following criteria: they (1) involve participants from at least two different stakeholder groups (e.g. researchers and business people; experts and policy-makers; experts and laymen); (2) disseminate their preliminary results (e.g. analyses, tentative conclusions and policy proposals) among interested "non-participants",[16] e.g. face-to-face at workshops, electronically via the internet with free access for everyone, or in the form of printed documents, leaflets, newsletters; and (3) seek feedback from this wider circle (again, either face-to-face or in a written form). Conversely, if any of these criteria is not met, that activity cannot be regarded a participatory programme or project.

Finally, certain approaches are based on the assumption that the future is not pre-determined yet; and thus the future can evolve in different directions, to some extent depending on the actions of various players and decisions taken "today". In other words, there is a certain degree of freedom in choosing among the alternative, feasible futures, and hence increasing the chance of arriving at the preferred (selected) future state. Clearly, there is a close link between being action-oriented and considering alternative futures.[17] Other approaches, on the contrary, can only think of a single future, already "fixed" by certain factors, and thus the task is to explore (forecast, predict) "the" future scientifically.[18]

In sum, foresight programmes are action-oriented, participatory and consider alternative futures.

## 4.2 Focus of Foresight Programmes

Foresight programmes may have rather dissimilar foci, ranging from the identification of priorities in a strict S&T context to addressing broad societal/socio-economic challenges.

Luke Georghiou has identified three "generations" of prospective/strategic technological analyses (cf. Georghiou 2001, 2002). This classification is used here as point of departure to develop a typology of foresight programmes to analyse their potential and actual role in policy-making.

lowing the "futures studies" paradigm), see e.g. several articles published in "Futures", especially Vol. 36, No. 2. (More recently, a special issue of this journal has been devoted to this discussion: Vol. 42, No 3., see also replies published in later issues, e.g. Vol. 42, Nos. 5, 8, and 9.) It does not seem to be a productive, promising dispute trying to establish the "real" meaning of foresight, and then attempting to "enforce" it across various communities of practice.

15 E.g. the slogan of the first UK Foresight Programme was "Shaping our future".

16 "Non-participants" are those persons who have not been members of panels or working groups set up by the programme, and have not been involved directly in any other way, e.g. by answering (Delphi) questionnaires.

17 Some foresight programmes, e.g. the second Swedish Technology Foresight Programme, consider alternative futures with the explicit aim of identifying key choices confronting their "constituency" or "target audience", but do not intend to single out any preferred future. In other words, these programmes do not follow a normative approach. (This approach, and the example, has been mentioned by Göran Pagels-Fick among his comments on an earlier draft.)

18 Kerstin Cuhls offers an excellent, comprehensive discussion on the differences between forecasting, prediction, planning and foresight (cf. Cuhls 2003). The possibility of a single future vs. "many" futures is a central element of her analysis.

The first generation is the classical technological forecasting, aimed at predicting technological developments, based on extrapolation of perceptible trends.[19]

The main aim of a second-generation foresight programme is to improve competitiveness by strengthening academy-industry co-operation, correcting the so-called market failure[20] and trying to extend the usually too short time horizon of businesses.[21]

A third-generation foresight programme tackles broad/er/ socio-economic challenges, and hence besides researchers and business people government officials and social stakeholders are also involved.

Three "ideal types" of foresight programmes can be defined as major "reference points". Identifying "ideal types" is a long-established practice in social sciences (and somewhat similar to "models" used in all fields of sciences): "The fact that none of these three ideal types […] is usually to be found in historical cases in 'pure' form, is naturally not a valid objection to attempting their conceptual formulation is the sharpest possible form" (Weber 1947; reprinted in Pugh 1988, p. 16).[22]

Note, however, that all three ideal types of foresight programmes should meet the criteria defined above in Section 4.1: they should be action-oriented, participatory and should consider alternative futures. The underlying difference among them is their focus:

- S&T issues: type A foresight programmes;
- techno-economic issues: type B foresight programmes;
- broad societal/ socio-economic issues: type C foresight programmes.[23]

Their further characteristics, in terms of their aims, rationales and participants, are summarised in Table 1 below. One would notice immediately that these ideal types are not distinguished by their themes (topics): for example, they all deal with S&T issues, but by doing so, they pursue different aims, and follow different (policy) rationales. In other words, they address different challenges, ask different questions, use different approaches / ways of thinking,[24] and involve different participants. In other words, these ideal types should not be thought of as "Russian dolls": the biggest one, type C incorporating the middle one, i.e. type B, and, in turn, type B encompassing the smallest one (the "core"), Type A.

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19 These predictions are produced by a relatively small group of experts: futurologists and/or technological experts (that is, other types of expertise or actors are not sought after in the process of forecasting). The main objective is to predict which S&T areas are likely to produce exploitable results. Forecast results, in turn, are used in economic planning, either at firm or macro level.

20 In short, private returns on R&D are smaller than social returns (as firms cannot appropriate all the profits stemming form R&D), and thus firms do not invest into R&D at a sufficient – socially optimal – level.

21 Accordingly, a different set of actors is involved in these programmes: researchers working on various S&T fields and business people, bringing knowledge on markets into the process. These programmes are organised by following the structure of economic sectors (various industries and services).

22 It is just a coincidence that Weber also talks of three ideal types when discussing legitimate authority.

23 In short, the most important modification compared to the three generations identified by Georghiou is to replace technology forecasting with foresight programmes focussing on S&T issues. Technology forecasting projects usually do not consider alternative futures, and most of them are not participatory either (as defined above in Section 4.1). However, there is no reason to assume that S&T issues cannot be tackled in a participatory manner, considering alternative futures, and aiming at informing and influencing present actions. For example, the recent Turkish Foresight Programme – the Vision 2023 Project – has focussed on S&T issues (cf. Tümer 2004).

24 See section 4.4 for more details on the differences in terms of questions, approaches – when analysing the same theme (technological field).

**Table 1: Foci of Foresight Programmes**

| | S&T focus (type A) | Techno-economic focus (type B) | Societal/ socio-economic focus (type C) |
|---|---|---|---|
| Aims | Identify S&T priorities (following the logic of scientific discovery) | Identify research topics in S&T, of which results are believed to be useful for businesses | Identify research topics in S&T, of which results are believed to contribute to addressing major societal/ socio-economic challenges<br>Devise other policies – or identify policy domains, which are relevant – to tackle these societal/ socio-economic issues |
| Rationale | Boost national prestige, achieve S&T excellence;<br>Following the linear model of innovation, socio-economic benefits might also be assumed; implicitly or explicitly | Business logic: improve competitiveness<br>Correct market failures: strengthen academia-industry co-operation, extend the short time horizon of businesses | Improve quality of life (enhance competitiveness as a means for that)<br>Correct systemic failures, strengthen the National Innovation System |
| Participants | Researchers, policy-makers (e.g. S&T and finance ministries) | Researchers, business people, (some) policy-makers | Researchers, business people, policy-makers, social stakeholders (lay persons?) |

Author's compilation

Potential users usually constitute a broader group than the actual participants; they might include e.g. funding organisations, other policy implementation bodies and public service providers (including "quangos" [quasi-NGOs]), professional associations representing the interests of their members (and thus involving them to some extent in strategy and policy formation processes in various ways), venture capitalists, trade unions, etc. Depending on the focus of a foresight programme (the types of challenges/ issues considered), as well as the political culture of a given country or region, some of these potential users and stakeholders might become participants, too. In any case, it is not possible to establish a one-to-one relationship between an "ideal type" of foresight and its participants beyond the "typical" participants indicated in Table 1. The type and number of participants, the methods, channels and for a used their "internal" and "external" dialogues,[25] as well as the intensity, quality and impacts of these dialogues is obviously a question for the individual description, analysis or evaluation of actual foresight programmes.

Types A and B programmes have a longer tradition, and thus in general they are better known. Obvious examples are the Turkish Vision 2023 Project (type A) and the first UK Foresight Programme (Type B) (cf., respectively, Georghiou 1996; Tümer 2004).

Therefore, only type C programmes are explained here in some detail. The shift in focus is reflected in the structure, too: these programmes are organised along major societal/ socio-economic concerns (e.g. health, ageing population, crime prevention in the case of the Hungarian, the first Swedish or the second UK foresight programmes; see Figure 1 and Table 2 in Section 5.1). A new element in the underlying rationale can also be discerned, the so-called systemic failure argument: the existing institutions (written and tacit codes of behaviour, rules and norms) and organisations are not sufficient to improve quality of life and enhance competitiveness, and thus new institutions should be "designed" by intense communication and co-operation among the participants. In other words, the existing gaps should be bridged by new networks, appropriate policies aimed at correcting systemic failures, and establishing or strengthening relevant organisations. A foresight programme, based on this rationale, can deliver solutions in various forms: by strengthened, re-aligned networks as "process" results of the programme, as well as by policy recommendations ("products").

An actual foresight programme is likely to combine certain elements from various types. In most cases, however, one type of rationale would be chosen as a principal one; it thus would underlie the more detailed

25 Internal dialogues take place among the participants of a given programme, e.g. among panel members, between panels, between panels and the management team, between the steering group and panels – or any other internal groups of participants in case these ones have not existed. External dialogues are organised among the participants and other stakeholders, clients, target groups, etc., i.e. those, who have not participated in the programme in a direct way.

objectives and structure of a programme, as well as the choice of its participants. Otherwise, it would likely to lead to an incoherent – even chaotic – exercise, characterised by tensions between (a) the various objectives, (b) elements of its structure, (c) the objectives and methods, (d) the participants and objectives, and/or (e) among the participants themselves. A certain level of tension, however, might be quite useful – or even essential – to produce creative, innovative ideas and solutions, of course, but too intense and too frequently occurring – structural, inherent – conflicts would most likely tear a foresight programme apart.

# 5 Coherence of Foresight Programmes

## 5.1 Themes and Time Horizon

At a first glance, the focus of a foresight programme determines the themes to be discussed / analysed to a large extent. For instance, as already alluded, typical themes for a technology forecast or a type A foresight programme would be specific fields of science and technology, such as microelectronics, communications, bioinformatics, energy technologies, new materials, bio- and nanotechnology. These topics have been dictated to a non-negligible extent by "fashion" or fads, too: earlier much had been written on nuclear and space technologies, then came ICT to yield significance, and more recently the fields denoted by prefixes of "bio-" and "nano-" have taken the centre stage.

The time horizon can be driven by the dynamics of a given discipline or the imagination (agenda) of the futurists. For the latter, perhaps an extreme example is when Graham T. T. Molitor predicts the weight and height of human beings in 3000 (cf. Molitor 2000). He has also published a book entitled "The Next 1000 Years". It is not uncommon, however, to try to predict major events in a 50-100 years time horizon.

The so-called critical or key technologies method is also concerned with technological fields – as its name clearly indicates – but in this case the time horizon is much shorter, usually 5-10 years, as it is derived from policy-makers' needs to set mid-term priorities.

A typical type B foresight programme, e.g. the first UK one, deals with economic sectors, such as chemicals, construction, financial services, food and drinks, leisure and learning, retailing and distribution, transport, as well as technological fields, such as aerospace and defence, communications, IT and electronics, life sciences, materials. The time horizon in this case was 15-20 years, similar to a number of other national foresight programmes.

At a national level, only a handful of type C foresight programmes have been conducted so far. As already mentioned, these are concerned with broad societal / socio-economic issues, such as human resources, health, ageing population, crime prevention, usually with a time horizon of 20-25 years.

| UK 1st Round (1994-1999) | UK 2nd Round (1999-2002) |
|---|---|
| Science driven sectors | Thematic panels |
| Chemicals | Ageing population |
| Defence and aerospace | Crime prevention |
| Health and life sciences | Manufacturing 2020 |
| Materials | Sector panels |
| Exploitation sectors | Built environment and transport |
| Communications | Chemicals |
| Financial services | Defence aerospace and systems |
| Food and drink | Energy and natural environment |
| IT and electronics | Financial services |
| Policy driven sectors | Food chain and crops for industry |
| Agriculture, natural resources and environment | Healthcare |
| Energy | Information, communications and media |
| Retailing and distribution | Marine |
| Transport | Materials |
| Human resource and management driven sectors | Retail and consumer services |
| Construction | |
| Leisure and learning | |
| Manufacturing, production and business processes | |

**Figure 1: UK1 and UK2 Foresight Themes**

Source: http://www.bis.gov.uk/foresight/about-us/history; documents of the first and second rounds of the UK Foresight Programme

**Table 2: Hungarian and Swedish Foresight Themes**

| Hungarian Foresight Programme (1998-2000) | Swedish Foresight Programme (1998-2000) |
|---|---|
| Human resources | Health, medicine and care |
| Health (life sciences, health care system, life style, pharmaceuticals, medical instruments) | Biological natural resources |
| Natural and built environment | Society's infrastructure |
| Information technologies, telecommunications, media | Production systems |
| Manufacturing and business processes (new materials, production processes and management techniques, supplier networks) | Information and communications systems |
| Agri- and food businesses | Materials and material flows in the community |
| Transport | Service industries |
| | Education and learning |

Source: documents of the Hungarian and Swedish national foresight programmes; http://www.nih.gov.hu/english/science-technology-and/technology-foresight, and http://www.dimea.se/customers/tfOld/old/eng/index.html, respectively

## 5.2 Different Approaches to the Same Theme

A premature conclusion from the above examples would suggest a mechanistic link between the focus and themes of a given foresight programme, as well as between themes and time horizons. A more detailed look, however, would reveal there is no strict one-to-one relationship in either case. E.g. information and communication technologies (ICTs) are usually analysed by all sorts of foresight programmes – with important differences, of course:

- In a critical (key) technologies programme the emphasis would be on specific technological terrains of this broad field, usually with a 3-5-year time horizon, and hardly any attention would be devoted to social issues (e.g. exclusion – inclusion of certain social groups; gaps between generations, or regions, cities and villages; e-democracy; regulations on, and incentives for, different types of content; etc.).
- A type A foresight programme would also put the emphasis on – the usually assumed positive – technical aspects (including perhaps also the overall impacts on the society in general, i.e. not differentiated/

elaborated by social strata; but not considering the potential impact the other way around, that is, how socio-economic needs and trends would shape technological developments). These programmes opt, however, usually for a significantly longer time horizon (say, 20-25 years) than the one used in a critical (key) technologies programme.

- A type B foresight programme is likely to focus on broader technological fields – as opposed to specific sub-fields analysed by the critical technologies approach.[26] It would pay much more attention to the economic (market) aspects than the above ones, and perhaps would discuss some social factors, too, as they shape demand, but not much elaboration can be expected on social challenges (either dealing with the new ones caused/ accentuated by ICT or asking how ICT can contribute to tackle existing social challenges). The usual time horizon is around 10-15 years when this approach is chosen.
- A distinctive feature of a type C foresight programme is the marked, deliberate shift towards precisely to those societal / socio-economic aspects which are neglected by all the other approaches, and thus mentioned above as “negative examples”. Technical aspects, however, are not ignored by this approach, either, but discussed in a different context (also usually in a more integrated way, e.g. ICT and various types of media are understood as a complex, closely inter-related entity): other types of questions are asked, and new drivers and shapers come to the forefront. The time horizon, therefore, is also determined by the socio-economic issues identified by the programme: it would depend on the amount of time required to change the underlying settings, to influence the major shaping factors so as to achieve a certain (desirable) future state. (In other words, the time horizon cannot be shorter than the period of time needed for a change aspired by the programme.)

ICT has been used as an example here because it is – by definition – a technology, and as it is a significant one; thus, it is no surprise at all that various types of technology foresight programmes would deal with this issue. Non-technological topics – such as human resources, crime prevention, etc. – on the contrary, are only addressed by type C programmes as major issues. (This is not to be mistaken with the fact that some socio-economic factors might be included in a type B foresight programme as shapers influencing market dynamics – as mentioned above.)

Finally, it goes without saying that some inherent features of a given topic to be analysed also have repercussions on the time horizon. Usually changes take much more time e.g. in the field of agriculture (classical breeding), environment, education or in demographic trends than in rapidly evolving technologies, such as ICT or biotechnology. These determinants should not be ignored, and various themes / topics of a given foresight programme, therefore, might have different time horizons.

In sum, although there is a great deal of overlap in terms of broad themes discussed by various types of foresight programmes, a closer look clearly shows that these apparently same topics are dealt with in rather different manners. A different focus means that different approaches are applied when analysing seemingly similar issues: a different set of questions are asked, and hence various – social, technological, economic, environmental and political – factors and values are taken into account to a different degree (some of these factors not at all in certain foresight programmes) by a different set of participants (technology experts, business people, researchers, policy-makers, lay people). The time horizon, in turn, is determined to some extent by the inherent (technical, social, etc.) features of the various themes, but also by the focus (main objectives) of the programme, in which these topics are taken up.

## 6 Conclusions

Decision-makers face increasingly complex issues, given that economic, technological environmental – and thus social – challenges are brought to any nation state rather quickly, due to the forces of globalisation, and these challenges are usually inherently inter-linked. Technological changes cause economic, environmental and social threats and opportunities; economic resources are required to finance public policies aimed at tackling these issues (e.g. harnessing technological change, preventing environmental crises, preventing social explosions, etc.); and government policies are under ultimate social control (in democratic societies through a number of institutions, formal and direct, as well as informal and indirect ways, in other cases by more costly, more radical, yet, less frequently applied mechanisms).

Both theoretical considerations and actual cases clearly show that foresight can be a relevant decision-preparatory tool in a number of policy fields – well beyond science and technology. In other words, it is

[26] Yet, in the first UK programme, IT, electronics and communications were not integrated into a single panel.

time to embrace this broader notion of foresight. This paper has attempted to contribute to the diffusion of this new understanding by distinguishing and discussing three different foci of foresight programmes, namely pure S&T, techno-economic and societal/ socio-economic ones.

Foresight processes can assist decision-makers in this complex environment to reduce technological, economic or social uncertainties by identifying various futures and policy options, make better informed decisions by bringing together different communities with their complementary knowledge and experience, obtain public support by improving transparency, and thus improve overall efficiency of public spending.

It is crucial to prove the relevance of foresight for decision-making: its timing and relevance to major issues faced by societies, as well as the quality of its "products" – reports and policy recommendations – are critical. Only substantive, yet carefully formulated proposals can grab the attention of opinion leaders and decision-makers, and then, in turn, the results are likely to be implemented. Otherwise all the time and efforts of participants put into a programme would be wasted, together with the public money spent to cover organisational and publication cost. The so-called process results – e.g. intensified networking, communication and co-operation among the participants – still might be significant even in this sad case, but they are less visible, and much more difficult to measure. Thus, the chances of a repeated programme – when it would be due again given the changes in the circumstances – are becoming really thin.

Foresight can be relevant even in emerging countries, too, not being in the forefront of technological development but rather in the semi-periphery. A number of factors seem to contradict this conclusion at first glance. Foresight is costly in terms of time and money, but even more so in terms of the participants' time required by meetings, workshops and surveys. Moreover, advanced countries, whose experts, in turn, know more about the leading edge technologies, regularly conduct their foresight programmes, and their "products" – reports, Delphi-survey results – are readily available. Yet, only a national programme can position a country in the global context and spark a discussion on how to react to major trends. Similarly, SWOT of a given country would not be analysed by others, let alone broad socio-economic issues. Process benefits cannot be achieved without a national programme either. Without these, a country would not be able to improve the quality of life of her population and enhance her international competitiveness.

The current structural changes in the world economy and the emergence of new, global concerns related to environmental, health and demographic issues, imply that the scenario method may be relevant not only in transition economies, per se, but also in countries with long-established, crystallised institutional systems. A growing body of literature suggests that technological and socio-economic changes are intertwined. Scenario workshops, therefore, can contribute to a better understanding of these complex relations, leading to policy proposals, which help in making appropriate choices in an increasingly complex environment. Further, the Delphi-method, taken alone, can facilitate the foresight process only to a limited extent, and thus the process benefits are bound to be limited, too.

Yet, it is important to highlight some dilemmas, too, which are partly to do with policy, and partly methodological in character:

- How to solve the inherent contradiction between the long-term nature of foresight issues (policy recommendations), on the one hand, and the substantially shorter time horizon of politicians (and some policy-makers), on the other?
- What organisational set-up is necessary to ease another inherent contradiction between the need for a strong (but "reserved") political support (or "embeddedness") for a foresight programme on the one hand, and for enjoying intellectual, organisational, financial independence from any government agency, on the other?
- How to overcome the departmentalised government structures when policy proposals tackling complex issues (such as health, quality of life, environment, competitiveness, etc.) should be discussed and implemented, i.e. public resources – both financial and intellectual ones – should be pulled together to make a real difference in an efficient, that is, co-ordinated way, yet, they are allocated to different ministries and other government agencies?

International co-operation can enhance the chances of success by sharing lessons, easing the lack of financial and intellectual resources through exploiting synergies and economies of scale. Yet, its more ambitious form, i.e. a joint foresight exercise on trans-border issues also necessitates methodological innovations. International organisations can also facilitate foresight programmes in emerging countries, and more specifically collaboration among them. It is crucial, however, to maintain the commitment of local actors, e.g. in terms of time and funds devoted to the programme, willingness to implement of the results. In other words, the main forms of foreign assistance should be the provision of knowledge-sharing platforms and other fora to exchange experience (among emerging economies as well as with advanced countries), monitoring and evaluating foresight initiatives in the CEE region.

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# Prospective Technology Analysis for EU Level Governance of Research and Technological Development. Challenges, Problems and Possible Solutions

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## 1 Introduction

Prospective technology analysis activities have a history reaching back at least several decades: Herbert George (H. G.) Wells pointed out the need for professors of foresight in a BBC broadcast as early as November 19, 1933.[1] Recent interest in most countries of the world has been aroused by foresight, initially at the national level. Many countries have in the past decade hosted national foresight exercises, covering a broad range of scientific, technological, and increasingly social, topics. Countries that conduct national foresight studies also pursue other, similar, activities – some labelled foresight and others bearing names such as technology forecasting or technology assessment.

The label given to an activity does not permit any automatic conclusions on goals, approaches and methods. Two activities bearing different labels may have greater similarities with respect to process and methods than two activities bearing the same label, but taking place in a different context with different primary or secondary addressees. However, they address a range of technology-related subjects, draw on a common toolbox of methods, and intend to inform decision-making of one kind or another.

## 2 Types of Prospective Technology Analysis

It is possible to distinguish several alternative analytical forms of prospective technology analyses (cf. Rader/Porter 2006):

- *Technology intelligence* – monitoring information on technological development
- *Technology foresight* – studies to identify possible technology-related futures
- *Technology forecasting* – attempts to predict the actual progress of technology
- *Technology roadmapping* – the identification of milestones along a specific trajectory of technological development
- *Technology assessment* – the comprehensive assessment of opportunities and risks of technologies and their application.

Such a list is not without its problems, since activities of certain kinds, like technology forecasting or technology roadmapping, can form part of another kind of study, such as technology foresight or technology assessment.

Despite the lack of distinct definitions and an amount of interchangeability of labels, there are certain essential features that affect types and methods:

- Apart from some limited scope technology forecasting, such prospective activities *seldom aim to predict "the" future*, instead exploring possible futures of varying degrees of likelihood. Predictions on the availability of technology (technology forecasting,) are quite frequently made and used in broader activities, but it is rather more difficult to predict applications and diffusion of technology, so these topics are themselves frequently the subject of more exploratory analyses (cf. Medina Vasquez 2006).
- In some cases, a *specific future is regarded as desirable* and an aim is to identify measures which could lead from the present state of affairs to this desirable future ("backcasting"). "Visions" like those developed by the German "Futur" activity or the NBIC initiative of the National Science Foundation and the US Department of Commerce serve a similar purpose, usually in a narrower sphere. *Roadmapping* pursues similar aims by defining milestones in the development of a technology and its applications.
- *Technology assessment* originally emerged with the aim of contributing to the balance of power between the legislative and executive branches of government, but has increasingly moved towards

[1] This was pointed out in Miles/Keenan 2003, p. 41.

providing knowledge suitable for *actively shaping* technology. This has led to the emergence of such concepts as participatory technology assessment, constructive technology assessment, discursive TA, consensus conferences etc.

- *Foresight* usually covers a broad range of technologies, increasingly also including the societal context of technology applications. The best known early technology foresight studies were on so-called "critical" technologies regarded as key to future economic development. While there has been an aversion to anything suggesting centralised national S&T planning in the US and, therefore, no national foresight, most foresight in other countries has been commissioned by national governments. In countries with a tradition of centralised planning, there is a danger that foresight will be misunderstood as a new tool of central planning (cf. Böhle/Rader 2003, p.7).
- An important factor driving foresight activities has been *globalisation* and the attendant *shift in the role of nation states*. The *identification of promising areas* of science, research and technology likely to add to the attractiveness of certain locations for job creation has led, on the one hand, to stressing the network building functions of foresight – creating dialogues among the various actors and stakeholders with an interest in technology – and on the other hand to a shift from the level of the nation state to more local levels, where regions or cities compete as attractive locations for research and its economic spin-offs.
- In all, foresight has *shifted its focus* away from the state to a broader range of stakeholders, including industry, resulting to some extent in a "convergence" of US prospective technology analysis emphases, such as competitive technical intelligence and roadmapping, with those of Europe.
- Contrary to some popular perceptions, such as the distinction between TA, foresight and technology forecasting made by the ESTO network (cf. Rader 2001, p. 4, but revised in Tübke et al. 2001), technology assessment can be focused either on a specific technology or group of technologies *(technology-driven TA)*, or on technology-related problems *(problem-driven TA)*. Since TA is frequently dealing with complex technological innovation issues beyond the control of the state, the results of TA studies are increasingly addressed to coalitions between the state and societal actors, including experts, political and industrial decision makers, and stakeholders of all kinds (cf. Petermann/Coenen 1999).
- A major *distinction between foresight and technology assessment* was formerly the *range of technology* covered by exercises: the best known technology foresights address a broad range of technologies while technology assessments are narrowly focused. However, more recently *foresight* in countries which have conducted broader exercises has *tended to focus more on specific cases*. The Futur process in Germany is organised starting very broadly and narrowing the field as a result of consultation until it produces a limited number of "guiding visions" ("Leitvisionen"), intended to provide the framework for state S&T endeavours. After two cycles of classical foresight, the United Kingdom foresight programme was reshaped to focus on such specific topics as coastal protection and cognitive systems. The activities under these headings are difficult to distinguish from activities labelled "technology assessment" elsewhere.

A further distinguishing feature between foresight and technology assessment is the *time horizon*, which is typically 30 or more years for foresight and rather shorter for technology assessment. The first Swedish foresight (cf. STF 2000) project pointed out the "Zeitgeist"-Problem related to this aspect: the tendency to be captive to "the spirit of the times" and to assume that tomorrow's problems and visions will be very much the same as today's. This implies that the persons involved in the foresight tend to examine rather shorter ranged futures than hoped. An additional problem in this respect is that progress in some areas of technology is much faster than in others, so that foresight here is more difficult than in areas of slow movement.

## 3 The Use of Prospective Technology Analysis for RTD Governance

Most EU member countries and many other countries and regions have performed large-scale *foresight* studies of various types. An important subset of these are studies aiming at the identification of *critical technologies*, often using the Delphi method.

The main aim of national and regional foresights is to inform agenda-setting in research, science and technology policy. National level studies have been conducted in most of the EU Member States, the bulk up to about 2005 but some, like Luxembourg or the Slovak Republic, more recently. Additionally, foresight methods have been used for regions or municipalities, so that recent activities have covered smaller territories. During this phase, there have been a number of what PREST researchers have called "fully fledged foresight", the "networking of key agents of change and sources of knowledge, around the development of strategic visions based on anticipatory intelligence" (Miles/Keenan 2003, p. 42).

The Czech national foresight study actually had the aim of developing a draft national research and development programme, but most others have aimed at less direct impact, i.e. pointing out science and technology related options and their likely impact, to inform decision-making. The methods employed for this purpose cover a broad range and most foresight studies are not limited to a single method. The primary objective is frequently to achieve a consensus among stakeholders on priorities for science and technology policy in the hope of optimising the return on the investment of public funds in research and technological development. Secondary benefits include the creation of networks among groupings of stakeholders which in some cases continue to exist after the foresight activities themselves have been completed.

The concept of comprehensive, future-oriented *technology assessment* was popularised by the now defunct U.S. Office of Technology Assessment which worked for the US Congress. Presently, the term "technology assessment" is most closely associated with *activities for parliaments*, although it is also used for activities not directed in parliaments, mainly in German-speaking countries. Several national and regional parliaments in Europe have their own semi-permanent capacities for TA, some even created after the demise of the OTA, and most recently the European Parliament has signed a framework contract with a group of these parliamentary TA units to provide services to its own panel with responsibility for TA, STOA (Scientific Technological Options Assessment).[2]

According to the political context, the purposes of such activities can vary greatly. The critical technologies lists in the US were intended to help orient American R&D investment toward areas of economic importance. This is achieved mainly via *general awareness*, not explicit mandate setting. Elsewhere, studies focused on critical technologies have at best been used to inform national or regional decision-making on priorities although there has seldom been a direct, visible relationship.

Except in extreme cases where foresight has been connected strongly with agenda-setting (e.g. in the Czech Republic or Ireland), it is difficult to gauge success in terms of influence on the process. In several cases it is possible to assume that foresight has been regarded as useful by its clients, since these have either set up institutional arrangements for continuous foresight activities (e.g. OPTI in Spain, the Foresight Directorate in the UK) or commissioned new foresight (Sweden, Germany).

In the case of parliamentary Technology Assessment, there is in many cases a direct link between the topics covered by TA studies and ongoing legislation. A crucial factor for the success and destiny of institutions serving parliaments in this way is timeliness: one reason given for ceasing to fund OTA was that the studies did not fit well with the pacing of legislative activities. The link between the legislative process and TA activities is possibly a factor working against the success of these activities. A more promising approach might be that of "early warning" and creating understanding of science and technology: the studies for the STOA panel of the European Parliament have no direct link with ongoing legislation processes, but serve to pinpoint critical aspects of technologies and their application which might require the attention of legislators at some later point in time. Even here, there is the possibility that research might be overtaken by ongoing developments, such as those we are currently witnessing in the energy sector.

The TAMI project has identified a non-exhaustive list of 21 specific roles that Technology Assessment has played in individual projects. Correspondingly, the project develops a typology of impacts, related to three issue dimensions: technological/scientific, societal, political/policy oriented, and three impact or goal dimensions: Increasing Knowledge, Forming attitudes or opinions, Initialising actions. The typology is actually the result of decomposing TA projects into individual steps, each with a distinct role and target. It is suggested that *"(t)he introduction of the concept of roles reveals that TA plays more roles and has more impact than usually appreciated"* (Decker/Ladikas 2004, p. 19; italics in original, M.R.). The selected methods result from the issues which are the subject of the studies and from the roles the project has to play, i.e. the individual roles/goals into which it can be decomposed.

We can distinguish several roles for such activities in governance. An important distinction is whether they are designed to be used for specific on-going decision-making or to provide a basis for decision-making at some time in the future (early warning function). A second dimension is the kind of decision, i.e. regulatory (laws, regulations, standards etc.) or financial (on spending of budgets). There is furthermore a difference

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[2] Cf. http://www.itas.fzk.de/eng/etag/etag.htm.

in the type of output: recommendations versus collection of facts, identification of stakeholders and positions and possibly a discussion of available options.

# 4 European Level Activities

The Framework programmes of the European Commission have tended to use different labels for very similar activities: the fifth Framework Programme included measures for Technology Assessment, the sixth addressed Foresight with a special unit assigned responsibility for activities, which included some originally labelled and funded as "technology assessment". Among the major activities of the unit has been the setting up of a "foresight knowledge sharing platform", the European Foresight Monitoring Network, coordinated by TNO.[3]

The closest Europe has ever come to a fully-fledged comprehensive foresight project covering the whole European Union was the IPTS "Futures" project which ran from mid 1998 until early 2000. While it involved almost 200 experts as panel members, it made no attempt at the involvement of citizens or even representatives of major stakeholders. Apparently, the Commission President's Cellule de Prospective will in the near future embark on a study focussing on the year 2020 (personal communication, November 2007).

In a more narrow area, the IPTS-led foresight project FISTERA (Foresight on Information Science Technologies in the European Research Area) and its successor EPIS06 (European Perspectives on the Information Society – the 06 stands for the year the project started, there are tentative plans for an EPIS08 or 09), were foresight projects specifically on information and communications technology or, in the case of FISTERA more precisely on a specific vision of future societal development, namely the information society. The ultimate aim for these activities is to inform the Directorate General responsible for support of research and development in the area (DG INFSO) in a timely fashion to develop the framework programme or the specific programmes for information and communication technologies. The author has also been involved in a recent specific support action for the foresight unit in Directorate General Research which is intended to inform agenda setting for the social sciences and humanities in connection with convergent technologies, most prominently nanotechnology, biotechnology, information technology and the cognitive sciences.

A second focus will be on the work labelled as technology assessment currently being performed by a group of parliamentary technology assessment organisations using the collective name European Technology Assessment Group (ETAG[4]). The "client" is the STOA (Scientific Technological Options Assessment) panel of the European Parliament.

# 5 Informing Decision-Making on S&T Priorities

The FISTERA project started in September 2002 as a Thematic Network under the Fifth Framework Programme. It was set up to contribute to building the European Research Area in Information Society Technology (IST) research. Its objective was "to contribute to a common vision and approach towards the Information Society in an enlarged Europe in 2010. It aimed to create a pan-European platform on foresight in Information Society Technologies (IST), involving a wide range of key EU and national IST policy makers and players" (Compañó et al. 2006, p. 7).

The FISTERA project employed multiple methods including analysis of existing foresight reports from Europe and beyond for their findings on information society technologies, the setting up and maintenance of a database on information and communication technologies and possible trajectories for their future development, an identification of important players in research and development to position Europe relative to its competitors on the global scale, a series of workshops, initially on a regional basis and later on an interest group basis, plus an online Delphi exercise seeking to involve experts from Europe and beyond.

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3 Cf. http://www.efmn.info.

4 At this writing, the full members of the group are the Danish Board of Technology, the Flemish Institute of Science and Technology Assessment, the Parliamentary Office of Science and Technology (UK) and the Rathenau Instituut of the Royal Dutch Academy of Sciences, led a coordinated by ITAS, which is the "mother" institution of the German Bundestag's Office of Technology Assessment.

A final synthesis report with the main findings from FISTERA was published in 2007, so here we will only concern ourselves with policy related aspects.

The Delphi survey revealed that the majority of respondents saw national governments and firms in IST as the two 'key players' for improving the development and deployment of IST applications in nearly all areas. European institutions were expected particularly to contribute to the improvement of applications for social welfare and public services; cultural diversity; transport and work organisation. The actors in the field expected the EU to undertake social and institutional innovations and to focus especially on reducing the "digital divide". Additionally, the EU was expected to contribute towards the improvement of the communications infrastructure, to support new and improved applications of information and communications technologies and to create training and awareness programmes.

Some of the recommendations derived from FISTERA research are targeted at setting priorities, while others are aimed at stimulating generic competencies in order to address specific weaknesses due to existing specialisation patterns, since the long-term development of the competence base seemed to matter more than short-term technology programmes. In this way, it was hoped to be better prepared to make the best of opportunities created by unexpected technological disruptions.

Despite the internationalisation of R&D in IST, the results of FISTERA confirmed the important role played by very large players. Europe-based firms are well represented in the world league of IST, but there is a lack of the large and medium-sized players. Thus, another recommendation was for RTD policy to also keep the second and third tier of IST firms and research organisations in focus.

The EPIS06 project pursued a roughly similar approach to FISTERA, its predecessor, but its activities related to developments in ICT in general were rather less elaborate – the FISTERA database was succeeded by a monitoring activity compiled in a "Monitoring Synthesis Report" – and a novel feature was a so-called real-time Delphi, which no longer has separate rounds but allows participating experts to have feedback and change their opinions at any time. Another major difference to FISTERA was that EPIS focused its attention mainly on a single application area rather than all information society technologies, in EPIS06 this focus was on creative content.

## 6 Informing Decision-Makers to Provide Early Warning

The European Parliament's Scientific Technological Options Assessment (STOA) Panel celebrated its 20th anniversary with an exhibition on the Parliament's premises in Strasbourg on June 19 of 2007.[5] Since 2005, STOA has had a framework contract with a group of technology assessment institutions working for national or regional parliaments in Europe.[6] This arrangement is leading to the production of a series of reports, based mainly on a review of existing literature and the consultation of experts. In particular the former European Commissioner for Science, Philippe Busquin, in his function as chairman of the panel, has noted several times that such reports would also be of interest to national parliaments, especially those without their own capacities for technology assessment.

Prior to the framework contract with ETAG, STOA had commissioned individual reports from universities or other institutions and the new arrangement had been set up to provide more effective advice to parliamentarians.

The STOA panel is composed of delegates from the permanent committees of the European Parliament, such as those for Industry, Research and Energy, the Environment, Employment or Agriculture. Each of these committees can also commission specific work needed to inform ongoing legislation, so that the work for the STOA panel has more of an "early warning" function by examining new or emerging technologies for any aspects that might require future attention from the parliament, be it for priority-setting for future framework programmes of the European Commission, be it in the shape of legislation.

As stated before, the reports produced under the framework contract are based mainly on reviews of existing literature and expert interviews or workshops. More ambitious methods are largely precluded due to costs: the annual budget of the panel is in the region of half a million Euros, which is less than a quarter of the budget of the German Parliament's TAB, on which STOA is to an extent modelled.

5 See http://www.europarl.europa.eu/stoa/events/workshop/2007_experience/default_en.htm [July 17, 2007].

6 Cf. also footnote 4. The group is known as The European Technology Assessment Group (ETAG) – cf. http://www.itas.fzk.de/eng/etag/etag.htm.

# 7 Lessons from European Level Work

## 7.1 Foresight

Experience from FISTERA shows that few findings from national foresight can be transferred to the European level, or even from one European country to the next. The choice of the best method for an own foresight study depends on the national context and cannot be copied without considering factors of context, such as responsibilities for science and education, the organisation of research etc.

The European dimension usually plays a minor role in foresight considerations targeted at the national or regional levels. An aggregation of the findings from national and foresights reveals differences within Europe rather than common interests. Thus there is a genuine need for regular pan-European monitoring and foresight studies to provide a basis to help overcome this apparent fragmentation and draw attention to the potential of European cooperation and collaboration in endeavours to overcome challenges usually exceeding the capacities of the individual member states.

Another argument in favour of foresight efforts on specific technologies is the degree of granularity at the level of individual technologies: the more "universal" technology foresight studies at the national level, like most of those analysed by FISTERA, attempt to develop rather broader strategies at the expense of detail. Thus more specialised studies are required to devise strategies for a more specific area of technology like IST.

Creating a *European* vision cannot be based on the sum of national visions. Although the making use of results of the national foresight exercises is a necessary pre-condition, an active participation of the stakeholders with a view beyond their national interests is necessary. Creating a European dialogue would be a suitable platform towards constructing this vision. FISTERA's approach was face to face dialogues with approximately 600 Persons, who participated in one of the 11 roadshow workshops in the Member States and 10 thematic meetings at the European level. More than 150 persons from 20 countries participated the final conference. This approach does not, however, sufficiently respond to the challenge of achieving representative European participation.

Online Delphis, while a relatively effective method of involving geographically dispersed stakeholders, have also some clear limitations. First, to motivate online participation requires a lot of effort. The response rate is low (on average below around 10%). There is some resistance against responding online, and stimulation of potential respondents with email is difficult, in particular if the sender is an unfamiliar institution. It is thus advisable to involve local organisations with good reputations to underline the seriousness of the survey. Secondly, the quality of an online Delphi is not comparable to a face-to-face exercise. Online animation of the process cannot replace the spontaneity resulting from human interaction.

The original intention was for a two-way relationship between the users and producers of the technology database set up for FISTERA: about 400 persons used this service per month[7] but very few actively contributed to its development or population.

FISTERA found that a key element to success was the participation of decision makers as an integral part of the foresight process and not only as the mere receivers of the end products. In the course of the project, FISTERA succeeded in attracting a high number of decision makers from industry and public institutions,[8] however, only a fraction of them participated regularly in events. Considering that on one hand decision makers have many commitments, and that on the other success depends on their active participation in the foresight process, practitioners have to take this into account when designing the process and the planning.

The FISTERA Report argues that priority-setting needs to be built on clear and transparent arguments, especially when there is a need to justify and legitimise public policy intervention. Among the building blocks deployed to fulfil this condition are:

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7 The database receives about 5,000 Hits per month of which 400 visitors interrogated the database for longer time periods (> 5 minutes) and FISTERA considered them "users".

8 FISTERA has contributed to numerous advisory boards of the European Commission And in the FISTERA conference, 30% of the participants were regional, national or supra-national policy makers, and 30% were industrialists.

- identification of the emerging scientific-technological trajectories outlining the emerging future opportunities space,
- identification of socio-economic needs and requirements to which technology applications are expected to contribute in the future,
- identification of strengths and weaknesses of the European research and innovation system, also in terms of industrial structures,
- the global developments and strategies with which European actors will have to deal, like for instance internationalisation of R&D and the emergence of new strong players,
- vision and orientation with respect to the kind of desirable (information) society,
- an approach to interpret the findings on these building blocks in order to translate them into priorities and to justify public policy action at national and/or European level, aiming to realise research and innovation that take into account the S&T opportunities as well as the user needs and institutional settings for enabling their interaction.

Priority-setting requires interaction with and participation of actors and stakeholders, due to the often controversial nature of these issues and the recurrent lack of hard data. Participative approaches can support action more directly by informing and mobilising actors, and even contributing to the building of communities, to realise the priorities identified. Experience in FISTERA underlined a need to intensify the level of direct interaction with and involvement of the key actors in charge of priority-setting.

FISTERA made a considerable effort to share experiences of lessons learned on foresight and, indeed, its methodology influenced foresight exercises in several countries including Romania, Hungary, Austria, Poland and Colombia. Even so, the project was primarily intended to generate sound and topical policy-relevant results, rather than to push the methodological frontier of foresight forward.

EPIS06 employed a largely similar approach to FISTERA including participation via workshops and the Delphi method. The approach envisaged for the successor project foresees a more interactive approach for the technology monitoring activity, based to an extent to experience with online journals, such as epso-n, a newsletter established for discussion on electronic payment systems;[9] or the INDICARE Monitor used in a project on Consumer Issues in Digital Rights Management Systems.[10]

With regard to participation a pan-European project on brain science, the “Meeting of Minds” project, employed a method it termed “European Citizens’ Deliberation”.[11] This attempts to unite two possible routes towards citizen participation:

- The development of adapted versions of existing methods, such as citizens’ conferences or consensus conferences.
- The simultaneous implementation of national participative activities, the results of which are compared and synthesised for the European level.

In the case of the Meeting of Minds project, there was a pan-European citizens’ panel which received input from parallel national assessments. Use of such methods is obviously elaborate and only advisable if there is a genuine and urgent public dimension to the issue in hand. In most other cases, it is probably sufficient to set up expert panels with sufficiently broad expertise and national coverage.

## 7.2 Technology Assessment for the Parliament

In mid 2007, there was a discussion within the STOA panel on experience with its framework contract. On its own function for the parliament, the panel noted that science is vital to economic growth in the EU and therefore a necessary area of interest for MEPs. The quality of the reports was generally regarded as high, but it was noted that they had little or no impact. Although the reports were relevant for MEP work, the committees who originally proposed projects made little use of the projects and workshops which are a regular feature of each project are attended by a small minority of MEPs. The panel also noted that the studies did not engage MEPs, citizens or stakeholders sufficiently, and also, that once completed, the reports did not reach all their target groups.

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9 Cf. http://www.itas.fzk.de/deu/Projekt/pez/epso.htm.

10 Cf. http://www.indicare.org/tiki-page.php?pageName=IndicareMonitor.

11 Cf. http://www.meetingmindseurope.org/europe_default_site.aspx?SGREF=14&CREF=6688.

A major problem was that MEPs were time-challenged with insufficient time to read STOA studies. There was thus a need to build political interest, in marketing terms, “buzz” about the product. MEPs’ attention could best be captured by stakeholders and citizens alerting them to the significance of STOA projects.

Another suggestion to increase impact of studies was to approach the committees directly with both the final reports and offers for presentations. As noted before, STOA reports are not linked with ongoing legislation, so that it is important to insure that they are considered when a topic does find its way onto the parliamentary agenda.

The impact of projects could also be enhanced by better engagement of civil society and stakeholders through their reinforced attendance of and participation in workshops to discuss findings from studies. The panel also thought that efforts should be made to disseminate reports into the member states, in particular those without their own resources for technology assessment.

A criticism of the workshops concerned the style of presentation by the experts, described as “all too often … dry, long, boring, confusing or … ironically too basic”. While individual aspects might play some role here, there is also the fundamental question of requirements and specifications for such presentations which could be provided to help make them more interesting. Additionally, creative manners of presentation could be tested. There was also the question whether fully-blown, elaborate workshops should not be reserved for issues which are timely, stimulating wide parliamentary interest.

A major problem of detaching projects from the legislative agenda is that either the issue in hand is viewed as too remote to attract much interest from parliamentarians or that projects could easily be overtaken by events, so that results of research actually arrived too late to have any impact on parliamentary debate. Thus, the STOA panel recognised a need to better align its projects with the agenda of the parliament, the trick being to be sufficiently in advance to have sufficient time for the study before its subject reemerged on the parliamentary agenda.

There is already a network for parliamentary technology assessment institutions in Europe, known as EPTA (European Parliamentary Technology Assessment). A number of parliaments have their own scientific units to perform studies while others have more ad-hoc arrangements. Not all national parliaments in the EU have any institutionalised technology assessment activity, although, as the STOA panel notes, science is vital to growth and thus an area of essential interest to parliamentarians.

Thus, the STOA panel, and in particular its chairman as a past European Commissioner for Research, has set its sights firmly on the European dimension:

- As far as possible, replication of work done by researchers elsewhere should be avoided. An option is to have presentations in parliament by groups of researchers working at the national level in order to identify gaps or specific issues for the European level. This is also an option for national parliaments.
- Joint projects by several organisations could make more efficient use of resources, enable a wider scope and eventually lead to a common European or EU agenda on TA. Joint European projects could be larger in scale and capture the interest of media coverage more than a project on a national or regional level.
- Such joint projects would require advance planning by the parliaments concerned, but would enable a division of labour on specific tasks with the understanding that results of research would be shared and that marketing and promotion could be done jointly.
- This applies particularly to large scale issues of joint interest to all EU member states, such as climate change, ICT infrastructures, energy and transportation.
- More effort could be devoted to aspects of presentation of results. Responsibility for content could be shared among the participating research groups, which could also give presentations in the various parliaments. The quality of reports could also be improved for this reason.
- Another medium-range possibility is to have joint meetings between the bodies of the parliaments responsible for the projects concerned.

# 8 Conclusions

Problems of prospective technology analysis for European level governance can be divided into those which apply to the type of analysis in general and those which are only relevant at the European level.

The major *generic problems* concern participation of stakeholders and the *effective use of the results of studies*. In studies seeking to achieve a consensus or to reflect the range of positions and interests in a matter, adequate participation is an essential element for the success of the endeavour. The most effective method of participation is probably the workshop in which the various stakeholders are able to put forward and exchange their views on contested issues, but increasingly, and particularly for geographically dispersed actors, on-line methods such as discussion fora and online Delphi surveys are of growing attractiveness. Beside the approaches already mentioned, online newsletters[12] or focus groups[13] are interesting alternatives.

The effective use of the results of projects depends on such factors as involvement of the client and attractiveness, timely and compelling presentation of results. In the case of the European Parliament, involvement of a parliamentary “supervisor” does add to commitment, although this could be improved by involving representatives of other target groups of the activity, including other parliamentary bodies, and – with the necessary distance – also major stakeholders.

At the European level, with 27 member states in the European Union alone, representativeness of participation is a major issue, the more so, if there is any need to capture a cross-section of European positions and opinions. Online methods are certainly the most promising approach to ensure a sufficiently large number of participants, but even this requires careful planning, as is indicated by experience in the FISTERA project. Beyond this, the European Citizens’ Deliberation Method employed by the “Meeting of Minds” project (cf. Steyaert/Vandensande 2007) is promising through the combination of national level participation providing input for European level debate. On the debit side, this requires a great deal of effort and is probably only feasible for extremely important topics: to achieve effective participation requires participants to be able to converse in their own language, making interpreters mandatory (see the example of the European Parliament).

The effective use of studies has been a sensitive point ever since scientists have been writing reports produced by policy-makers. It has always been difficult to gauge the impact of researchers’ findings on decisions, even if they have been specifically commissioned to inform policy-making.

STOA work is directed towards the first two goals identified by the TAMI project (cf. Decker/Ladikas 2004) increasing knowledge – in this case of parliamentarians - and forming attitudes and opinions. To a lesser extent, it is oriented towards initialising actions in the future. Most foresight work targets all three, with an emphasis mainly on forming attitudes and opinions and initialising actions.

In all cases, it is important to involve the intended recipients and users of study results. In the case of the parliament, a start has been made by nominating so-called parliamentary supervisors for each project. Effective use of this arrangement requires involvement of the supervisor throughout the project to achieve his or her commitment to disseminate results among other parliamentarians or beyond. For studies whose main addressee is the administration of science and research policy, it is correspondingly important to achieve the involvement and commitment of “project officers” and others whose work is the target of the findings of projects.

In the specific case of foresight, an important effect is the creation of networks and relationships which can endure beyond the termination of the project. While face-to-face meetings are an enormous benefit for achieving this goal, on-line methods can also make a major contribution. This applies both to surveys and to methods designed to stimulate debate, such as interactive on-line journals and fora.

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# Parliamentary Technology Assessment as Part of Technology Governance

*Armin Grunwald*

## 1 Introduction and Overview

Technology Assessment (TA) constitutes a scientific and societal response to problems at the interface between technology and society (cf. Grunwald 2009). It has emerged against the background of various experiences pertaining to the unintended and often undesirable side effects of science, technology, and technicisation which, in modern times, can sometimes assume extreme proportions (cf. Grunwald 2010). The types of challenges that have evolved for TA are these: that of integrating at an early stage in decision-making processes any available knowledge on the side effects, that of supporting the evaluation of the value of technologies and their impact, that of elaborating strategies to deal with the knowledge uncertainties that inevitably arise, and that of contributing to the constructive solving of societal conflicts on technology and problems concerning technological legitimisation. What characterises TA is its specific combination of *knowledge production* (concerning the development, consequences, and conditions for implementing technology), the *evaluation* of this knowledge from a societal perspective, and the *recommendations* made to politics and society. TA is thus both interdisciplinary and transdisciplinary and in accordance with its research methods, it can be classified as a “post-normal science” (Funtowicz/Ravetz 1993) and as one of the forms of “new production of knowledge” (Gibbons et al. 1994), showing the following specific properties (following Grunwald 2009):

- *Orientation on Advice and Decision-Making*: TA supports public opinion and public participation in decisions on science and technology. In this endeavour, it aims at embedding TA knowledge and orientations into the perspective of decision makers: TA knowledge is knowledge for those who are to be advised. Because decisions always affect the future, a reference to the future is always included. TA always functions *ex ante* with regard to decisions.
- *Side Effects*: In TA, it is a matter of combining “comprehensive” decision support with the widest possible contemplation of the spectrum of foreseeable or presumable effects. Beyond classical decision theory, which establishes the relationship between goals and means according to the viewpoint of efficiency, TA turns its attention to unintentional side effects as a constitutive characteristic (cf. Bechmann et al. 2007).
- *Uncertainty and Risk*: Orientation to the future and the problems posed by side effects often leads to considerable uncertainty regarding TA knowledge. TA therefore always has to do with providing decision-making support in conjunction with complex innovations under conditions of uncertainty. The impact of such decisions is difficult to predict.
- *Value-Relatedness*: The rationality of decisions not only depends on knowledge about the systems involved and of the available action-guiding knowledge, but also on the basic normative principles. The disclosure and analysis of the normative positions involved is therefore also an aspect of the TA advisory service (e.g., depending on ethical reflection or sustainability evaluations; cf. Grunwald 2009).
- *Systemic Approach*: TA aims at achieving a comprehensive view of the fields affected. Several perspectives, e.g., from different scientific disciplines, have to be integrated into a coherent picture. Specific attention is dedicated to the systemic interrelationships between the impact of technology in different societal areas.
- *Broad Understanding of Innovation*: TA understands a broad notion linked to the term “innovation”. Beyond the mere technical understanding of innovations as new products or systems, TA contemplates social, political, and institutional innovations and does, in general, also consider socio-technical innovations.
- *Thinking in Alternatives*: When working on concrete projects, TA does not confine itself to a certain technology but always operates in an open window of possible alternatives. Presumed inherent necessities are broken down so that leeway for structuring can be gained. In concrete processes, the question of whether the results desired could not also be realized in a different manner is always posed. Alternative options are thus also examined which are not based on technology, but concern the political planning measures. “Thinking in alternatives” has thus become a specific TA tradition.

Against this description we can draw on the existing definition of TA which states that: "Technology Assessment (TA) is a scientific, interactive, and communicative process which aims to contribute to the formation of public and political opinion on societal aspects of science and technology" (Decker/Ladikas 2004, p. 1). This definition stresses that TA *contributes* to problem-solving, but does not pretend to provide actual solutions. TA provides knowledge, orientation, or procedures on how to cope with certain problems at the interface between technology and society societally but it is neither able nor legitimized to solve these problems. Only society can do this, through its institutions and its decision-making processes – and parliaments constitute the most prominent part of democratic decision-making. Therefore it is not surprising that TA has its origins in the parliamentary field and that technology assessment as scientific policy advice at the parliaments is still today an integral part of the whole TA landscape.

In this article I will first of all illustrate ongoing developments in technology assessment (Chapter 2). This will be followed by a short overview on the history and the current status of parliamentary TA, complemented by some short examples of institutional realizations (Chapter 3) and a more detailed description of the TA institution at the German *Bundestag* (Chapter 4). These descriptions provide the background information for the analysis of the functions and challenges of parliamentary TA in the overall context of technology governance.

## 2 Recent Developments in Technology Assessment

The basic idea behind technology assessment (TA), namely the prospective research and assessment of the societal aspects of technology as an aid to decision-making, originated in the U.S. Congress in the 1960s. The Office of Technology Assessment (OTA) in Washington D.C. was an influential institution for decades in the United States (cf. Bimber 1996). After several years that have seen TA decline in importance and visibility, we are currently witnessing its renaissance. There is now renewed awareness at the political level (for example in the seventh Framework Programme of the European Union and the European parliaments), a new demand for TA on the part of companies and engineers, an increasing interest in the growing Asian economies, and new recognition in academia. In addition, TA is increasingly involved in the development of a deliberative democracy and a civil society, mainly in the debates on technology-based futures and visions, and there is renewed interest in the social sciences and humanities. New concepts such as ethical, legal, and social implications of technology (ELSI) or environment – health – safety (EHS) studies can be regarded as specifications of the basic idea of TA to particular ends and purposes. The growing field of applied ethical research is a further indicator that can be interpreted as an outcome of earlier TA debates.

The background to this renaissance is the insight that though natural scientific and technical knowledge is *necessary*, it is not a *sufficient* condition for successful and responsible innovation. Qualified knowledge of the social contexts for which the innovations in question are intended – such as economic circumstances, social perception of problems, political and cultural frameworks – is just as crucial for the success of innovation. Technological development on the one hand and reflecting its consequences on the other, as practised by TA and ethics, belong together and may not be played off against each other as was occasionally done in the past.

In the past years, a new generation has arrived in TA. Young researchers and practitioners have newly joined up with the TA community. This renewal is also expressed in the concepts used. Classical TA regarded itself in no small part as an early warning system for risks caused by technology. This classical orientation has, however, now been quite considerably broadened, understanding TA as a contribution to technology governance, particular in areas of uncertain knowledge:

- "Constructive Technology Assessment" (CTA) claims the right to help shape technology according to social standards. Expectations (and fears) held by stakeholders, citizens, users, and affected parties are taken into consideration as early as possible in the course of technical development (cf. Rip et al. 1995).
- TA and innovation research have established common research and consultancy set-ups, particularly with regard to the theory of innovation systems (cf. Smits/ten Hertog 2007) and to research innovation pathways on new and emerging science and technology (NEST).
- Participatory TA concepts have been developed and applied to support technology design in a deliberative democracy and to contribute to overcoming technological conflicts (cf. Joss/Belucci 2002).
- Ethical questions have been taken up into the spectrum of TA topics. Biomedical research, genetic engineering, and nanotechnology are vital topics here (cf. Grunwald 2011; Swierstra/Rip 2007).

- In the context of increased public and political interest in future issues, prospective approaches such as technology foresight or vision assessment have increased in significance (cf. Grunwald 2009).

In modern TA, it is often not a question of the consequences of individual technologies, products, or plants, but frequently of complex conflict situations between NEST, enabling technologies, innovation potentials, patterns of production and consumption, lifestyle and culture, and political and strategic decisions. The challenge of "responsible innovation" can be seen as a core to which all of these research and assessment branches contribute, setting out from different premises, using different perspectives, and applying different TA methodologies (cf. Decker/Ladikas 2004).

# 3 Parliamentary Technology Assessment – an Overview

The *Office of Technology Assessment* (OTA), which was both the first TA institution in general and the first parliamentary TA institution in particular, was founded in 1972 with the aim to advice the United States Congress on decisions in the field of research and technology (cf. Bimber 1996). There were numerous reasons for its creation. First of all a very specific situation in complex decision-making processes on technology has to be mentioned directly. The further intervention of the state into technology development, the growing share of the budget which had to be spent for research and technology, and the requirements for a farsighted assessment of the impacts of certain programmes (or their neglect) created framework conditions which legislature was apparently not longer able to cope with. Secondly, this especially caused a problem concerning the democratic principle of the division of powers. Since the executive branch had complete access to the resources and know-how of many different institutions, its advantage over the more and more overstrained legislature grew constantly. This asymmetry regarding the access to and decision-relevant processing of knowledge threatened the balance of power between legislature and executive. Thirdly, there was a need for a reliable institution to assess complex technology questions. The distinct lobbying in the United States increasingly blurred the boundaries between pure information and the recommendations which were influenced, for example, by the interests of an industrial sector. Finally and fourthly, the strengthening of the environmental movement and a gradual realization of the problem of technological side effects resulted in the conviction that technology assessment has to play a stronger role in decisions on research and technology. In the history of TA the latter is often described as the dominant driving factor. However, it was just one of several aspects of a heterogeneous motivational set for the development of TA.

Against this background, the purpose of the OTA can be outlined as: Establishment of a competence for scientific advice, early warning and early detection, bundling of information for political decision-making, elaboration of alternative solutions and assessment of the respective consequences, consideration of external expert knowledge, and regaining the public's trust into the legitimacy of political decision by participatory elements. By the time of the closure of the OTA in 1995, more than 700 TA studies were published[1] together with a multitude of background papers and workshop documentations. At times the OTA had considerable influence on parliamentary decision-making. Many laws can be traced back to OTA studies, e.g. laws on the securing of the energy supply, prevention of air pollution, or the storage of nuclear waste. The closure of the OTA in 1995 was primarily due to the fact that the Republicans, who held the majority in both the Senate and the House of Representatives after the elections in 1994, were eager to reduce the influence of the state in the framework of their "neoconservative revolution"; OTA seemed to be a suitable symbol (cf. Bimber 1996).

Soon after the creation of the OTA several European countries started to discuss if similar institutions were needed in Europe as well and how they should be organized. Already in 1973 the German *Bundestag* held a debate where the then opposition (CDU) called for the introduction of an "Agency for Technology Assessment". However, it took considerable time to realize it. Only in the second half of the 1980s several European countries established (mostly small) institutions for parliamentary technology assessment (cf. Peissl 1999). Since then, the number of these institutions has been growing slowly but steadily.

The individual European countries established conceptually and organizationally different models of parliamentary technology assessment (cf. Cruz-Castro/Sanz-Menendez 2004; Petermann/Scherz 2005; Vig/Paschen 1999). These institutions vary in their degrees of freedom and independence from parliament, e.g. regarding their right to choose their topics, different degrees of scientificity, different levels of im-

[1] Cf. http://www.wws.princeton.edu/~ota/ns20/legacy_n.html.

portance of participation and effects on the public; some of them also vary considerably in their size and infrastructure, their access to processes of parliamentary advice, and their organizational embeddedness. In the following examples I will briefly introduce some of these TA institutions (cf. Cruz-Castro/Sanz-Menendez 2004; Petermann/Scherz 2005).

The *Scientific and Technological Options Assessment* (STOA), the TA institution of the European Parliament, can be indirectly traced back to the foundation of the American OTA. The first attempt to establish a "European Office of Technology Assessment" failed in 1975. After tedious discussion the second try in the late 1980s ended with the test run of STOA (cf. Wennrich 1999). Following a positive evaluation in 1992, STOA was integrated into the administrative structure of the European Parliament. The European Parliament is the sole addressee of the work of STOA. Its objectives are to improve the bases for decisions of parliamentary work by analyzing the dimensions of impacts and to develop and assess options for action. The STOA panel consists of Members of the European Parliament, decides on the general orientation, determines the annual work programme, approves reports, and takes, if necessary, political action. Until 2004, the majority of the reports for the parliament were prepared by administrative staff and temporary external personnel. This model did not prove itself; the large number of projects and the high fluctuation of people in charge did not allow an in-depth processing of the topics and it was almost impossible for STOA to establish a profile. As a consequence, the system was changed in 2005 into a model with a strong involvement of external competencies. Since then, the STOA reports have been prepared by a European network of parliamentary technology assessment (European Technology Assessment Group ETAG[2]), sometimes supported by other scientific institutions (cf. Hennen et al. 2008).

The Dutch *Rathenau Institute*[3] was founded in 1986. Right from the beginning it was not only based on the concept of early warning and early detection for preparing and optimizing parliamentary decision-making, but also aimed for a broad societal discussion of technology and its impacts. The Rathenau Institute is an independent institute under the administrative responsibility of the Royal Netherlands Academy of Arts and Sciences and sees itself as "an integral part of the wider process of social negotiation around science and technology" (Est/Eijndhoven 1999, p. 428). Participation of stakeholders and the public are considered as a means to increase the legitimation of parliamentary advice on technology-related subjects. Apart from directly advising the parliament with the results of scientific impact analysis, Rathenau is trying to incite a public debate on technology with precise statements, specific events, and the use of mass media.

The reasons for the foundation of the British Parliamentary Office of Science and Technology (POST) were similar to those of OTA: the parliamentarians' lack of information regarding science and technology in view of upcoming important and, above all, expensive projects and failures of some technical projects which were approved without prior impact assessment. The "Parliamentary and Scientific Committee" was created in 1979 against this background and pursued the establishment of a TA office, which was launched for a trial period from 1989 to 1992, funded by private sponsors. Afterwards POST was granted proper parliamentary funding. POST is working as a 'bridge' between parliament and the expertise of science and industry and is using a network of external expertise (like TAB, cf. Chapter 4).

In 1990, parliamentary TA institutions teamed up to form the European Parliamentary Technology Assessment Network (EPTA[4]). Founder members were POST, TAB, the Rathenau Institute, the "Danish Board of Technology", the "Office Parlamentaire d'Evaluation des Choix Scientifiques et Technologiques" (OPECST, France) and STOA. Meanwhile Catalonia, Finland, Flanders (Belgium), Greece, Italy, Norway, Sweden, and Switzerland joined the network, too. Austria, Poland, the Sub-Committee on Science and Ethics of the Parliamentary Assembly of the Council of Europe, and the Belgian Federal Science Policy Office are associate members. EPTA is guided by the EPTA Council which consists of the directors of the TA institutions and the responsible Members of Parliament. The most prominent activity is an annual conference which is organized and hosted by the TA institute of the country that holds presidency at that time. Its aim is to exchange information, agree on new subjects, strengthen the co-operation, and recognize new transnational developments.

During the last years, the European co-operation has been intensified. Parliamentary TA is traditionally oriented on national policy traditions and cultures; this includes the use of the respective national language and makes cross-border co-operation difficult. However, in the meantime a number of joint projects were

2 Cf. http://www.itas.fzk.de/eng/etag/about-etag.htm.
3 Cf. www.rathenau.nl.
4 Cf. www.eptanetwork.org.

carried out by EPTA members to identify a European perspective beyond national viewpoints on topics like genetically modified plants or the protection of privacy, a database has been set up which can quickly provide information on the research results of other EPTA members on a certain subject, and first externally funded projects were realized in the European Framework Programme (cf. Decker/Ladikas; Joss/Belucci 2002).

## 4 The Office of Technology Assessment at the German *Bundestag*

The *Office of Technology Assessment* at the German *Bundestag* (Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag, TAB[5]) was founded in 1990, and has become a permanent institution of the German legislature. The purpose of the TAB is to provide contributions to the improvement of the legislature's information basis, in particular, of research- and technology-related processes of parliamentary discussion. Among its responsibilities are, above all, drawing up and carrying out TA projects, and – in order to prepare and to supplement them – observing and analyzing important scientific and technical trends, as well as societal developments associated with them (monitoring). Since 1990, the TAB has been staffed by the Institute for Technology Assessment and Systems Analysis (ITAS) of the Karlsruhe Institute of Technology (KIT). The TAB is strictly oriented on the German *Bundestag's* and its committees' information requirements. The TAB's principal is the Committee for Education, Research, and Technology Assessment. The choice of subjects for TA projects as well as their delimitation and specification is the *Bundestag's* responsibility. Obviously, setting the agenda is itself a political and no scientific prerogative. Decisions on the urgency of problems and the scientific advice desired belong on the political agenda. The choice of topics and of problems to be treated is a political responsibility, which, of course, is supported by expertise.

Furthermore, the decisions made in the preliminary stages of a TA project have decisive influence on the results obtained and on determining which questions can be answered. With the design of a TA project, it is also determined which aspects of the investigation, which interactions, or which segments of a subject area are relevant for the desired analysis or problem solution, and which are not. Preliminary decisions about the scientific disciplines which are to participate in providing information and on the experts to be consulted also belong in this category. These preliminary decisions are frequently made by TAB, in a dialogue with the legislature.

The distinction between a descriptive (value-free) phase of "comprehension" of the consequences of technology and a subsequent phase of evaluation, as is presupposed in the decisionistic model of decision-making and in earlier conceptions of TA, is a fiction: what can be comprehended depends on previous decisions. At the initiation of a technology assessment, the decisions are made in which respects and in which dimensions of the problem knowledge of consequences is at all desirable. For this reason, the actual TA investigations are often carried out in the TAB as so-called "pre-studies", the purpose of which – besides an initial appraisal of the state of research – consists in a transparent, comprehensible, and purposeful inquiry into the possible research designs, the formulation of questions, goal directions, etc. The legislature then has the opportunity to decide on a reflective clarification of the subject matter and the design of the respective TA project. Treatment of the topics set in this manner by the legislature is carried out by the TAB in scientific independence and neutrality (cf. Grunwald 2006).

The TAB is a small unit (at present, ten scientists). The various requests and topics are treated by obtaining a number of expert opinions on the respective subject from scientific institutions. The results of this groundwork are evaluated by the TAB team, are concentrated on the legislature's advisory requirements, and are summarized in the form of a report to the legislature. By means of this networked method of operation, the pertinent competence and knowledge of the science system can be mobilized, case- and subject-specific, for the legislature's purposes in decision-making. The results of TAB studies sometimes (seldom, however,) lead to *Bundestag* resolutions, sometimes they have indirect influence on processes of opinion formation and decision-making in the legislature.

The subjects of the TAB's studies stem from all fields of technology. The "classical" TA subjects, such as technology and the environment, energy, and bio- and genetic engineering, predominate. But there are also studies on selected fields of science and technology (e.g., on new materials, on specific defence technologies, or on nanotechnology), and on specific technical projects (such as the space shuttle system "Sänger").

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5 Cf. http://www.tab-beim-bundestag.de.

In the last years, there are an increasing number of studies on medical technologies and on information and communication technologies. The following TA issues are examples which are currently performed:

- electric mobility concepts and their significance for the economy, society and the environment
- supply of raw materials for High-tech German industries – specifying and further developing Germany's raw materials strategy
- technological advances in healthcare: A source of rising costs or an opportunity for cost savings?
- white Biotechnology: Present status and future perspectives of industrial biotechnology for a sustainable economy
- sustainability and Parliaments: Survey and Perspectives RIO +20
- electronic petitioning and modernization of petitioning systems in Europe
- international competitiveness of the European economy with regard to the EU state aid policy: The case of nanoelectronics
- pharmacological and technical interventions for improving performance: Perspectives of a more widespread use in medicine and daily life ("Enhancement")
- renewable energy sources to secure the base load in electricity supply: Contribution, perspectives, investments
- how can research contribute to solving the problem of world food?
- hazards and vulnerability in modern societies – using the example of a large-scale outage in the electricity supply.

## 5 Parliamentary TA as Part of Technology Governance

Parliamentary TA is part of TA which is giving policy advice. It is about advising political actors within a framework that is by and large based on the structures of the nation state. In order to be able to analyze the role of parliamentary TA for technology governance, we have to take a closer look at the general role of the state in technology governance first. Obviously TA provides policy advice under the assumption that political actors and institutions play at least a rather important role in technology governance. However, this precondition is controversial in the current historical situation. At least two opposing points of view have to be considered:

a) The state in the outdated form of a nation-state has lost its scopes for design to other actors like industry, supranational institutions, actors of civil society, or informal and non-hierarchic processes and is, if at all, only sought-after as moderator of societal processes of communication. This general diagnosis (cf., e.g., Willke 1983) also applies for technology governance so that one can no longer refer to a regulation of technology by the state (cf. Grimmer et al. 1992). Instead of policy advice now 'society advice' is in demand.
b) Technology is created by engineers in the industry, companies, and concerns. The state should not fancy itself as being the better engineer. Instead of policy advice concerning technology the industry as the real powerful actor should be advised.

As often, there is a point in these positions, but they do not justify the sometimes very far-reaching conclusions.

Concerning (a): Also in modern and less hierarchically structured societies the democratic state with its institutions and procedures remains the sole place to produce legitimized, generally binding decisions. Of course this also applies for decisions which concern technology and are binding for all, i.e. as long as they are subject to democratic opinion-making and decisions for *societal* technology design (cf. Grunwald 2000). This is not affected by governance-critical interpretations in political and social sciences (cf., e.g. Grimmer et al. 1992; Willke 1983) in general (cf. Grunwald 2000) – however, these diagnoses lead to new requirements on the accomplishment, legitimization, and realization of technology-relevant decisions.

Concerning (b): The fact that technology development is definitely mainly taking place in the industry under market conditions does not result in industry having de facto the largest relevance in *societal* technology development. If "n" aspects of a new technology which is introduced into the market are societally relevant, then 'm' of these aspects are already covered by regulative or otherwise normative parameters (environmental norms, safety regulations, technical standardizations, general statutory provisions, etc.). The relation between n and m may differ in the individual cases: the difference will be much bigger in ethically and politically relevant questions than in the optimization of the marginal benefit of established technologies. Here one distinction has to be kept in mind: Which aspects of technology are *"subject to policy"* in the sense that generally binding decisions are related to them, and which of them can be left to the free interplay of supply and demand on a market? Policy-advising TA only covers technology aspects which are subject to policy, like safety and environmental standards, the protection of citizens against encroachment on their civil rights, the setting of priorities in research policy, the definition of framework conditions for innovations, etc. This is exactly where the largest part of parliamentary TA is taking place.

The political system influences technology development in at least four aspects (cf. Grunwald 2000, chap. 3, and the literature quoted there):

1. as demander and user of technology on a larger scale, e.g. in the field of computing;
2. as direct initiator of technology, e.g. concerning large infrastructures and the military;
3. as sponsor of science and technology in the framework of research- or technology-political programmes and projects;
4. as designer of the framework conditions for technology development, e.g. regarding taxation laws, liability law, securing data privacy and copy right, determination of environmental and safety standards.

Decisions on these options for action in policy which influence technological progress require a democratic deliberation and opinion-making in a democratic public, at least if democracy is more than just formal procedures (cf. Habermas 1992). Especially in terms of societal technology design public opinion-making and deliberation are important aspects of societal processes of self-reassurance regarding the own perspectives on technological progress and its impacts on the future society. Decisions based on this are made in a system of democratic institutions and procedures – and this is where policy-advising TA ties in.

Concerning *parliamentary* TA as a subcategory of policy-advising TA, the above-mentioned general precondition for policy-advising TA, namely the fact that the system which has to be advised needs to play a crucial role in technology governance, has to be tightened: necessary assumption is *that parliamentary action is relevant for technology governance*. It is obvious that this assumption is facing problems since the role of parliaments in democratic decision processes is often categorized as declining, sometimes as hardly noticeable any more. The possibilities of parliamentary TA are not only limited by the restricted role of the state in technology governance, but also by the restricted role of parliaments in the distribution of power in democratic systems. If parliamentary TA is institutionalized in such a system (cf. Chapter 1), the influence of parliamentary TA also depends on its institutional realization within this framework given by external circumstances. In an analysis of the roles of parliamentary TA in technology governance based on a theory of institutions, a variety of possible combinations of different institutional configurations occurs (cf. Cruz-Castro/Sanz-Menendez 2006), which is also enriched by the characteristics of the democratic institutions of a nation state and various political traditions.

## 6 Challenges of Parliamentary TA

The relevance of parliamentary TA was undoubtedly very high at the time of its evolvement – otherwise the evolvement would be difficult to explain – but in the "post-parliamentary era" it is, also without a doubt, if not threatened, then at least challenged. The functions of parliamentary TA for parliaments in their role in technology governance which are normally mentioned – the most prominent ones being provision of information for parliaments, elaboration of options for action and alternatives, assessment of the current level of knowledge, and provision of orientation in the case of expert dilemmas (cf. Vig/Paschen 1999) – might have to be reassessed against this background or new functions could arise. They might include:

- the active dealing with forms of 'democratization of technology' which is still a task to be solved (cf. Martinsen/Simonis 2000; Mensch/Schmidt 2003), both as a way of transparently dealing with technological progress in parliaments and active involvement in public debates;
- the use of parliamentary TA to strengthen parliaments as a platform for societal debates on future developments, e.g. regarding ethically relevant debates (e.g. on stem cell research, future of the nature of humans): with the support of TA parliaments could distinguish themselves as reflexive organizations (cf. Petermann/Scherz 2005);
- the scope of action of nation states concerning technology questions is changing through globalization and Europeanization – TA could contribute to enabling parliaments to bring in their democratically legitimized mandate in the newly emerging governance regimes;

- in the light of the increased legitimization requirements of the civil society TA could contribute by participative methods to increasing the 'responsiveness' of the political system to public debates (cf. Petermann/Scherz 2005);
- parliaments as "prospective" institutions can raise attention for new challenges and possibilities in connection with technology – they would be initiators of debates and not only responsible for the final implementation of results which were achieved without their involvement; here the prospective function of TA is needed.

In general these considerations are about conceiving TA as an opportunity for parliaments, as it was meant in the early days of parliamentary TA. In view of some positive evidences – EPTA is growing slowly but steadily, parliaments which to date had hardly anything to do with TA are interested now, in some countries the debate on sustainability assessment (cf. Grunwald/Kopfmüller 2007) follows the experiences with parliamentary TA – there are few reason to worry. Vice versa there are numerous possibilities of further development of parliamentary TA, not only in the framework of technology governance but also in the field of political communication.

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# Technology Foresight in China and its Future Development

*Fan Chunliang*

## 1 Introduction

Since the early 1990s, technology foresight has prevailed in many countries. The primary rationale is the widespread recognition that emerging generic technologies are likely to have a revolutionary impact on industry, the economy, society and the environment over coming decades. The aim of technology foresight is to identify potentially important emerging technologies at as early stage as possible and to facilitate their development (cf. Martin 1996). Like other countries, China began its own technology foresight in the early 1990s. In the early stage of the 1990s, the approach of Selection of Critical Technologies had been dominant and several such projects had been implemented. Since 2000, several technology foresight exercises have been done by the Ministry of Science and Technology (MOST), Chinese Academy of Sciences (CAS) and the local Government such as Beijing and Shanghai, and they have great influenced both on public and relevant policy making. This paper begin to summarize briefly the traditional approach of S&T foresight and selection priority areas in S&T planning and the approach of Selection of Critical Technologies in 1990s, then focus on two important technology foresight exercises in China since 2000 – the project of "Technology foresight in China towards the year 2015" initiated by MOST and the project of "Technology Foresight towards 2020 in China" which was initiated by CAS.

## 2 The Traditional Approach of S&T Foresight and Selection Priority Areas – *The Mid term and Long term S&T Plan*

Since its founding, China has been using *Mid-term and Long-term S&T Planning* as a powerful policy tool for S&T development. For 1956-2001, China had set up seven *Mid-term and Long-term S&T Plans* as shown as Table 3.

**Table 3: Seven Mid-term and Long-term S&T Plans (1950s-2001)**

| | **Name** | **Time** |
|---|---|---|
| 1. | Long-range Plan for National Development of Science and Technology, 1956 -1967 | 1956 |
| 2. | Outline of National S&T Plan,1963-1972 | 1962 |
| 3. | Outline of National S&T Development, 1978-1985 | 1978 |
| 4. | National S&T Plan, 1986-2000 | 1982 |
| 5. | 1991-2000 S&T Ten Year Plan and Outline of the Eighth –Five Year Plan | 1991 |
| 6. | The Ninth-Five Year Plan of National S&T and the 2010 vision | 1995 |
| 7. | The Specific Plan for Science and Education of the tenth-Five Year Plan for National Economic and Social Development | 2001 |

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The plan model is: mid-term and long-term S&T plan – five year implement plan. Usually the S&T plan consists of three parts: (1) strategic goals; (2) priorities; (3) main tasks.

For example: Long-term Plan for National Development of Science and Technology, 1956-1967:

1. *Strategic goals*

Focus on some important areas and catch-up.

2. *Six Priorities*

- the emerging S&T areas which are pivotal for national industrialization and national defense;
- investigation for Chinese natural resources which is a foundation for regional development, industry and agriculture;
- major S&T projects for national heavy industrial construction;
- major S&T projects for agriculture and forestry;
- major S&T projects for people's health;

- basic research.

3. *12 Major Tasks*

The Plan was formulated by two phases:

1. every Government department (including CAS) proposed its strategic plan;
2. various expert meetings identified the priorities and main tasks.

In view of the strategic significance of these plans, it is quite necessary to forecast and assess the future development directions, demands, capabilities and measures for technologies while identifying strategic goals, priorities and main tasks. In other words, all the previous plans for science and technology in China involved some kinds of technology foresight. The foresight mainly relied on experts' experience, but lacking systemic methods.

Since 1990s, as Chinese S&T system reform made progress, the technology foresight began to be put into practice and it has undergone a process from learning to practice.

## 3 The Approach of Selection of Critical Technologies in 1990s

The technology foresight in China began its way by learning from foreign experiences. In the early 1990s, the American government published "National Critical Technologies List", which greatly influenced many countries including China. The relevant reports were translated into Chinese. Several studies on China Critical Technologies had been carried out. Two of the most influential studies were taken by government department. One was the "Critical Technologies for Chinese Economic Development in the Future Ten Years", initiated by the National Planning Commission (NPC; in 1994). Another was the "Selection of National Critical Technologies", initiated by National S&T Commission (NSTC; in 1992-1995).

Like overseas experiences, the methodologies started with an initial long list of emerging or new technologies, identifying explicit selection criteria and then using those criteria to produce a short list of the most important technologies for China.

The NPC Study selected 35 critical technologies in seven areas

- agriculture;
- energies and environment;
- communication and transportation;
- material and resource;
- information and communication;
- manufacture technology;
- biotechnology.

The NSTC Study selected 23 critical technologies in four areas

- information technology;
- advanced manufacture technology;
- advanced material technology;
- biotechnology.

The characteristics of the approach of critical technologies are: (1) technology is abroad, (2) limit investigation, (3) no explicit action to realization. The results of two studies provided a reference for the "$9^{th}$ Five-year-plan for S&T in China (1996-2000)".

## 4 China Technology Foresight Project (MOST, 2002-2006)

Since 2000, based on the technology foresight experiences in Japan, England, and other countries, China began its technology foresight exercises. There are two important exercises, one is the project of "Technology foresight in China towards the year 2015" which was initiated by MOST, another is the project of "Technology Foresight towards 2020 in China", which was initiated by CAS. The two foresight exercises have different aims and areas. In this section, we discuss the MOST's technology foresight project. In the next section, we discuss the CAS's technology foresight project.

## 4.1 Origin

Actually, China's first technology foresight exercise began early in 1997, when the research project "Technology Foresight in National Prior S&T Fields" was initiated. The project team selected 11 areas, but later, owing to the insufficiency of funds and the lack of experience in conducting comprehensive technology foresight, it only selected these three key areas: agriculture, information and advanced manufacturing.

This research project lasted for two years (1997-1999), the main method being the survey by experts. It produced useful results and accumulated experience for the future study.

Since 2000, the important of technology foresight had been recognized widely in China. In order to carry out technology foresight better, in 2001, the MOST assigned its affiliated institute – National Research Center for Science and Technology for Development (NRCSTD) to make a study on overseas technology foresight experiences. NRCSTD' research group made a study on foresight exercises in Japan, U.S., UK, Germany and South Korea. Based on the study, they proposed a detailed plan for the future technology foresight in China (cf. RG 2002). The MOST adopted the plan and assigned NRCSTD to put it into practice in 2002.

## 4.2 Aims

The aim of technology foresight is "to give more information to the planner and supply important references to the frame of National Medium- and Long-term Planning of Science and Technology (2006-2020)", as the conductor of the foresight project mentioned (cf. Yang et al. 2004, p. 169). Moreover, it had another aim, that was to stimulate new and continuing dialogue between the science base and industry, and forged tie between the institutes, universities and enterprises, namely Communication/Education function – one of 5C (Communication, Concentration, Co-ordination, Consensus, Commitment) as Ben Martin summarized (cf. Martin 1996). The main tasks include as follows:

- the analysis of the demand of economic and social development in China;
- the study for high technology development in 10 years;
- the critical technique focus.

## 4.3 Areas

The project based on the analysis of needs of economic and social development in China. The general target of this foresight was to fix some strategic critical technique groups in the focal high and new technology areas and important social areas. The survey conducted for three stages and covered nine areas from 2002-2006:

- first round investigation(2002-2003): Information and communication, life science and biotechnology, new materials;
- second round investigation (2004): Energy, resource and environment, advanced manufacturing;
- third round investigation stage (2005-2006): Agriculture, population and health, public security.

## 4.4 Organization

With support and direction by MOST, the project was in the charge of NRCSTD, cooperated with by other relevant units. The research organization was composed of consultation experts system (specialist's network in various research areas) and foresight investigation system. The later one consisted of the general research group (15 experts) and nine areas research groups (about 20 experts each group). Specialists in consultation experts system were selected based on the recommendation of members in each area research group.

## 4.5 Methodological Approach

1. *Delphi Survey*

Delphi method was used in the survey, and responses were consolidated through two rounds. Questionnaires were supplemented by some methods including seminar and expert discussions. The Delphi surveyed experts were about 500 in every area.

2. *Focusing on demand from industry and users*
This project paid great attention to demand from industry and users. One of the methods was to select a sizable proportion of experts from industry and users among the surveyed experts. In the first six areas, almost 30% experts from industry and user (30% experts from university, 30% experts from research institutes, 10% from other units). The proportion is high comparing with the low proportion of experts from industry and users among the total experts in China. For the last three areas (agriculture, population and health, public security), 15-20% experts were from users and industry.

## 4.6 Phases

The foresight survey in every area included three phases: (1) topics selection, (2) Delphi survey, (3) selection of national critical technologies:

1. *Topics selection*
Based on the study of area research groups and discussion among the general research groups and consultation with relevant experts, important technological topics lists for two Delphi surveys were identified as follows:
- information and communication (80/75);
- life science and biotechnology (79/83);
- new materials (59/64);
- energy (83);
- resource and environment (100);
- advanced manufacture (78);
- agriculture (114);
- population and health (99);
- public security (98).

2. *The Delphi process*
Two rounds of the Delphi survey were processed. Some indices such as I-index (importance index), H-index (high-technology industry index) and T-index (Traditional industry index) etc., were calculated, based on the survey data.

The response of questionnaires was of high quality, every technological topic was evaluated by 100 or so experts.

3. *Selection of national critical technologies*
Based on these interactive analyses, area critical technologies and national critical technologies were selected and each of them was a technology cluster of several technologies from the original technological topics.

During the whole period of the project, discussion with experts was important. Seminars were put up to exchange ideas with experts from technology groups in all stages. Some new ideals and some conclusions could be got in the discussion.

## 4.7 Results

The foresight has two results: one is the published reports and another is an unpublished report. Three foresight reports are “China’s Report of Technology Foresight 2003” (information technology, biotechnology and new material technology), “China’s Report of Technology Foresight 2004” (energy resource, environment and advanced manufacture) and “China’s Report of Technology Foresight 2005-2006” (agriculture, population and health, public security). The unpublished report is “National Critical Technologies Report”, which contains policy recommendation about lists of national the critical technologies to be developed in next ten years and some of the results adopted by the “National Medium and Long-term Planning of Science and Technology (2006-2020)”.

# 5 Technology Foresight of China towards 2020 Project (CAS, 2003-2007)

The technology foresight towards 2020 in China project was initiated by CAS and conducted by its Institute of Policy and Management (IPM) from 2003-2007.

## 5.1 Aims

The main aims of the project were as follows:

1. to set priorities for technology development, and to provide necessary recommendations for technology development;
2. to explore a set of systematic methods for technology foresight, which are suitable for Chinese development levels and characteristics;
3. to construct an interactive platform for government-industry-university-academia, and to shape the mechanism of communication, consultation and coordination for various interested stakeholders (cf. Rongping et al. 2008, p. 169).

Actually, due to the sponsor, its main aim was also to providing reference to the CAS Research System reform and the plan for R&D program too, but no explicit demand for policy suggestion.

## 5.2 Areas

The project selected eight areas, which were CAS's main strong research areas. The eight areas are as follows:

- information technologies;
- biotechnology;
- material science and technology;
- energy (2003-2005);
- resource and environment;
- advanced manufacture;
- chemistry and chemical engineering;
- space science and technology (2005-2007).

## 5.3 Organization

Under support and direction by CAS, the project was in the charge of IMP. One general research group (GRG) was established in IMP so as to be responsible for methodological issues and coordinating all operations of participants. And each research field established one Expert Group of Field (EGF) and several Expert Groups for subfields (EGSF).

## 5.4 Methodological Approach

The project also used the Delphi survey as MOST project. Because there lacked necessary and high-qualified experts and it is impossible to conduct a successful Delphi survey in a normal way with these experts. So some technology topics were chosen from the results of the Delphi Survey conducted by Japan, UK, Germany and South Korea, and some of them were selected by using the method of data mining for experts' reference. The EGSF is responsible for generating the draft of topics list on the basis of existing results of technology foresight in other countries such as Japan and Germany as well as the UK. The EGF is responsible for finalizing the technology topics list, which will be put into the Delphi Survey questionnaires. The 63 subfields and 737 topics in the eight areas were selected.

Two rounds of the Delphi survey were processed, an average of 300 experts participated in every area in the survey, more than 1/3 respondents filled in the questionnaires in the two rounds. It is worthwhile to point out that the generation of the second round Delphi questionnaire on the basis of the first round survey was the key to the success of the Delphi survey in this design. Up to November 2006 "Technology Foresight towards 2020 in China" had already completed the Delphi survey of eight fields.

The three groups of top 10 topics ranking based on the three indices: Integrated Index of Importance, Feasibility and the R&D Level of China.

## 5.5 Results

The results of the CAS' foresight project are published reports, including two kinds of reports, one is the Research Report, another is Experts review report. Four reports have been published: "Technology Foresight of China towards 2020" (cf. RG 2005), "Technology Foresight 2005" (ECR 2005), "Technology Foresight of China towards 2020 (continued)" (cf. RG 2008), "Technology Foresight 2008" (cf. ECR 2008). The first two reports focus on fours areas of information technology, biotechnology, material science and technology, Energy; the last two reports focus on fours areas of resource and environment, advanced manufacture, chemistry and chemical engineering, space science and technology.

The results of the foresight project have some impacts for S&T policy decision-making, which have some contributions to making the mid- and long- term planning for the Development of the CAS, especially the planning for high-tech development of CAS. The indirect impact is board. The abridged edition of books of research reports were presented to high-level leaders in the main government departments and local provinces to be as reference for mid- and-long term planning.

**Table 4: Comparison between MOST and CAS' Technology Foresight**

| | MOST | CAS |
|---|---|---|
| 1. Aims | explicit demand for policy suggestion | no explicit demand for policy suggestion |
| 2. Areas | Information technology<br>Biotechnology<br>New material technology<br>Energy<br>Resource and environment<br>Advanced manufacture<br>Agriculture<br>Population and health<br>Public security | Information technology<br>Biotechnology<br>Material science and technology<br>Energy<br>Resource and environment<br>Advanced manufacture<br>Chemistry and chemical engineering<br>Space Science and Technology |
| 3. Surveyed experts | 500 in every area | 300 in every area |
| 4. Orientation | pay attention to industrial need | more discipline-oriented |

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# 6 Conclusion

Technology foresight in developing countries is a process of learning (cf. Martin 1996). Technology foresight in China has made progress from learning to practice. Its achievements are the following:

First, it identified research priorities and critical technologies for long range national soc-economic development, which is helpful for policy making. Secondly, it established Chinese own method and expert-network. Thirdly, it is helpful to create "foresight culture". Its weakness is not enough demand pull and limited data/research.

The future of technology foresight in China may development along two lines: (1) More broad areas, not just S&T, but also social, environment issues, as UK did. (2) Upgrade it to more high level authority to be steered, such as "National Development and Reform Commission" (NDRC). In the special important fields, such us semiconductor illumination, it should make more detailed method technology roadmap.

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# Nanotechnology in Brazil: Scientists' Visions and Policy Making

*Noela Invernizzi*

## 1 Introduction

Beginning in 2000, programs and funds for research into nanosciences and nanotechnologies (N&N) – the study and manipulation of matter at the atomic or molecular level – gained importance in science and technology (S&T) policies worldwide.[1] Brazil quickly became part of this trend. From late 2000 to 2004 the main events took place that would galvanize an active policy for the sector and culminated in the N&N Development Program (PDN&N) as part of the Multi-year Plan for 2004-2007 of the Ministry of Science & Technology. Soon after, in 2005, a more comprehensive initiative, the National Program of Nanotechnology, was launched.

Introduced as revolutionary, N&N entered the arena of S&T policy and were presented to the media and the general public worldwide in an euphoria of visions of a future nanotechnological society. These visions are revolutionary not only in a technological sense but also in social and cultural terms. Their content is not just cognitive, but also involves interests, values, ideologies and concepts concerning the relationship between science, technology and society (cf. Grunwald 2004, p. 56). Let us consider for instance a report prepared for President Clinton entitled "Nanotechnologies: Shaping the World Atom by Atom" (cf. NSTC 1999). This title became a slogan for nanotechnology, putting forward a notion of a material world under an unprecedented degree of human control and precision (cf. McNaghten et al. 2005). Equally suggestive was the title of another report on converging technologies: "Converging Technologies for Improving Human Performance" (cf. Roco/Bainbridge 2002). This short sentence summarizes the strong vision of human enhancement, which predicts a convergence of man and machine to enlarge human physical and cognitive capacity.[2]

These visions, with their promises, seek to demarcate and legitimize an emerging field of research, guarantee funding and, naturally, influence the course of the technological development itself. However, these visions of techno-scientific progress also lead to criticism and public debate. In the case of N&N, the debate began early on in some developed countries. In the wake of the previous conflicts on biotechnology, some countries included in their N&N policies mechanisms for public information and participation.[3] In this environment we have seen both visions designed to gain public acceptance and political support for research programs and those attempting to cause resistance to specific technologies or programs.

Nevertheless, it is difficult to determine the precise impact of a vision or the dynamic of contradictions between diverging visions on the concrete configuration of research programs and the resulting technological developments. Vision assessment, a tool integrated with technology assessment, allows us to approach this matter. The purpose of S&T vision assessment is to analyze the sense, role, bases, values and interests subjacent to the visions in order to understand their influence on the dynamic of the debate in a specific technological field (cf. Fiedeler et al. 2005).

In this article, we propose to analyze the visions on N&N disseminated through the "Jornal da Ciência" e-mail (JC, "Journal of Science"), published by the Brazilian Society for the Progress of Science (SBPC).[4]

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1 In that year, President Clinton launched the National Nanotechnology Initiative, soon followed by N&N programs in other developed countries.

2 *"Human enhancement"* is the increase of cognitive and physical human capacities for work, heightening senses and prolonging of life through nanotechnological devices combined with other technologies, integrated with the organism.

3 The European Commission, for instance, encourages debates among European countries on the benefits and risks (both real and perceived) of nanotechnologies and their implications for society. Several experiments have been funded by the Framework Programs, such as Nanologues and Nanodialogues (cf. CN 2008). The United States National Nanotechnology Initiative includes research on the implications of nanotechnology for society, grouped into two categories: environmental health and safety, and societal dimensions (cf. NNI 2008).

4 The Brazilian Society for the Progress of Science is a civilian institution founded in 1948 to contribute to scientific and technological, educational and cultural development in Brazil, "taking a stance in matters pertaining to scientific policy and scientific and technological development programs that are in the real interests of the country" (http://www.sbpcnet.org.br/site/conheca/mostra.php?cod=473).

We are particularly interested in inquiring into the role of Brazilian researchers in formulating the visions of N&N that helped this new field of research being rapidly legitimized by their peers and the government, resulting in the recognition of N&N as a strategic area in Brazilian science, technology and innovation policies. The JC was chosen because it is a privileged resource for the diffusion of information and opinions within the scientific community. The 14,500 subscribers who receive the JC are mostly researchers, professors and graduate students.

The JC is not a peer-reviewed scientific journal, but rather a means of publishing news, articles and opinion papers on S&T. It is sent daily by e-mail to its subscribers and helps them to keep up with the main events and debates on policy and development of science and technology in the country.[5] The journal includes relevant reports from the national press, information gathered from or sent by S&T agencies, and opinion articles submitted by scientists. The views of researchers on N&N mostly appear in these writings when they are quoted as qualified sources in articles written by reporters. On other occasions, the researchers themselves make their opinions known directly in articles submitted under their own names. The articles also include opinions from policy makers who operate within government S&T agencies.

Although, in the articles we examined, we came across the opinions of many researchers who operate in the field of N&N – 56 developing the field itself, and six analyzing its implications for society, in addition to 13 policy makers (some of them researchers in N&N occupying positions as policy makers) –, it is necessary to take into account that these opinions are not representative of the whole community of scientists involved in N&N research since the editors of the JC are the ones who select the articles to be published. The scope of selection, however, is relevant to our investigation as we are dealing with the outlet of an organization of scientists who have traditionally been very active in debates on scientific and technological development in the country.

Reports on N&N were analyzed from 2002 (the first year in which the JC files were first made available on the website of the SBPC) to 2005. Over this period 175 reports on N&N were published. We excluded short announcements on conferences, courses, fairs and research calls as they contain only specific information about these events.[6] Therefore, our qualitative analysis is based on 107 articles.

Over this period N&N issues became increasingly frequent in the JC. In 2002 20 reports were published, rising to 24 in 2003, to 31 in 2004, and to 32 in 2005 (see Table 5). The subjects broached, in order of frequency, can be seen in Table 5. We can group the subjects dealt with over this period into three categories. The first includes general information about nanosciences, nanotechnologies and their potential applications and those applications already available, including the topics of "general information on nanotechnology and its applications", "reports on domestic and foreign research", and "companies and markets". Taken as a whole, these subjects are the most frequently dealt with during this time. The second category includes articles with information and discussions about N&N policy and the conditions of research in the country, including the topics of "S&T policies and funding for the sector in Brazil" and "infrastructure, researchers and organization of research in Brazil". These issues were heavily focused on in 2003 and 2004, a time when the general outlines of policy for N&N were being decided. Finally, the third category deals with the relationship between nanotechnology and society, including the topics of "Risks and economic, social, legal and ethical implications", "Regulation" and "Nanotechnologies and the public". The subjects included in this final category were far less numerous than the subjects of the first two categories.

5 JC is also distributed in printed form every two weeks and distributed to active members of the Brazilian Society for the Progress of Science; cf. http://www.jornaldaciencia.org.br/index2.jsp.

6 It is worth noting that there was an increase in information about events, announcements of research funds, fairs and conferences on N&N over the period under study, signaling the gradual introduction of the field into everyday research in the country.

**Table 5: Reports on N&N Published in JC, by Main Subjects**

| | Number of Reports | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| S&T policies and funding for the sector in Brazil | 3 | 12 | 8 | 5 | 28 |
| General information on nano and its applications | 7 | 5 | 5 | 7 | 24 |
| Foreign research reports | 4 | 4 | 2 | 4 | 14 |
| Infrastructure, researchers and research organization in Brazil | 4 | 0 | 6 | 2 | 12 |
| Risks and economic, social, legal and ethical implications | 0 | 2 | 6 | 3 | 11 |
| Brazilian research reports | 2 | 1 | 3 | 3 | 9 |
| Companies and markets | 0 | 0 | 1 | 4 | 5 |
| Nanotechnologies and the public | 0 | 0 | 0 | 3 | 3 |
| Regulation | 0 | 0 | 0 | 1 | 1 |
| **Total reports** | **20** | **24** | **31** | **32** | **107** |

Prepared by the author based on information from JC

In the following sections we will explore the content of the articles. Of this total, the sources for 65 articles are information from Brazilian researchers and the sources for 17 are the opinions of policy makers of S&T organizations of the Brazilian government (many of whom are also researchers of N&N), while 5 are based on communiqués issued by these organizations. Some of the articles use more than one of these sources. Twenty-two articles are based exclusively on foreign sources. Sources from the Brazilian business community are used in three articles; three others use sources from other sectors of society such as NGOs, social activists and politicians. Thus, views on N&N published in the JC are predominantly those of Brazilian researchers (see Table 6).

**Table 6: Reports on N&N Published in JC, by Source of Information**

| | Number of Reports | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Brazilian researchers | 9 | 15 | 24 | 17 | 65 |
| Policy makers of Brazilian Government S&T organizations | 3 | 5 | 4 | 5 | 17 |
| Communication of Brazilian S&T organizations/ institutions | 0 | 3 | 1 | 1 | 5 |
| Foreign researchers, exclusively | 7 | 3 | 6 | 6 | 22 |
| Others (NGOs, activists, politicians) | 0 | 1 | 0 | 2 | 3 |
| Brazilian companies or companies located in Brazil | 0 | 0 | 2 | 1 | 3 |

Note: More than one option is possible

Prepared by the author based on information from JC

We have organized the presentation of N&N visions in the JC into five sections. First, we draw a brief outline of the policy of science, technology and innovation for N&N in order to show the context in which these visions are developed. Second, we analyze visions on the future nanotechnological society, identifying the promises of nanosciences and nanotechnologies that are being spread. Third, we examine how far these visions allude to social, economic and ethical implications and the potential risks of these new technologies. Fourth, we analyze how these visions are used to legitimize a new field of research. Finally, we identify the main actors involved in spreading these visions. We round off the article with a few brief considerations and reflections.

## 2 Development of the N&N Policy in Brazil

The construction of the national policy for N&N in Brazil began under the government of Fernando Henrique Cardoso (1999-2002) with a workshop held in Brasilia, in November 2000, called “Tendencies of Nanosciences and Nanotechnologies”. This workshop was organized by the Secretariat of Policies and Programs of the Ministry of Science and Technology (MST) and the National Council for Scientific and Technological Development (CNPq). In this reunion, 32 researchers from different fields such as physics, chemistry, biology, and engineering reached an agreement about the necessity of creating a national program of N&N. An Articulation Group composed by ten researchers was created, with the purpose of identify the expertise of Brazil in N&N and elaborate an agenda (cf. CNPq Noticias 2000).

In April 2001, the Articulation Group presented a document identifying 192 researchers working in six areas connected to N&N in the country: (a) nanoinstruments, nanosensors and nanoelectronics, (b) nanoestructured materials, (c) nanobiotechnology and nanochemistry, (d) nanoscale processes with impacts and applications on the environment and agriculture and (e) nanometrology (cf. Knobel 2002).

In the same year, the CNPq acted rapidly in response to these reunions and it called for inter- and multidisciplinary research projects to run the Cooperative Networks of Basic and Applied Research on Nanosciences and Nanotechnologies with the purpose of creating and consolidating the national expertise in this field (cf. Knobel 2002). Three million *reais* were allocated for the project (one-million dollars according to the exchange rate at the time). The outcome was the creation of four research networks: Nanostructured materials, Molecular nanotechnology and interphases, Nanobiotechnology and the network of Semiconductor, nanoinstruments and nanostructured materials. Each network was composed of scientists, universities and research centers from different parts of the country.

In addition, the MST and the CNPq have promoted, since 2001, four institutes for research in new materials and nanosciences, as part of the Millennium Initiative financed by the World Bank, which goal is to push excellence level scientific research in strategic areas for the development of the country (cf. MCT/CNPq 2002).

In the same year, the efforts of the Coordination for the Improvement of the High Level Personnel (CAPES) of the Ministry of Education were integrated, granting six scholarships in Nanotechnology in partnerships with the Brazilian Association of Synchrotron Light (cf. CAPES 2005).

Still during Cardoso's government the creation of a Nanotechnology Reference Center, linked to the MST was proposed. This center would have the dual mission of stimulating academic research and encouraging the use of new technologies by the private sector. These ideas were embedded in the first National Program of Nanotechnology coordinated by the Physicist Cylon Gonçalves da Silva, Emeritus-Professor of the Universidade Estadual de Campinas and former director of the National Synchrotron Light Laboratory (cf. Silva 2003). Shortly after the change of government, the project was abandoned and the opening of the laboratory was cancelled because it was argued that the project consumed too many resources that could be used by other laboratories.

When Luis Ignacio Lula da Silva became president in 2003, the MST created a new program, under the supervision of Dr. Fernando Galembeck, another professor of the Universidade Estadual de Campinas. In 2003, a Working Group, coordinated by Gallembeck, was created by the MST to develop a National Program of Nanoscience and Nanotechnology. The final proposal was submitted to public consultation and it was later incorporated to the Multi-year Plan 2004-2007 of the MST. The estimated budget for the four year project was 78-million *reais* (approximately US$ 28-million). The objective of the program was to develop new products and processes from nanotechnology in order to increase the competitiveness of national industry. It recommended actions to implement and support laboratories and networks, as well as the implementation of institutional projects focusing on R&D (cf. MCT 2003).

In the Industrial Technological and Trade Policy, presented by the government in 2004, nanotechnology is depicted an area "bearer of the future", reinforcing the strategic importance that the government granted to this field (cf. Teixeira 2004). The year 2004 was also decisive for the organization of collaborations with the Argentinean Republic, through the creation of the Bi-national Center for Nanotechnology Brasil-Argentina.

Still in 2004, the MST proposed again the construction of a National Laboratory of Micro and Nanotechnology worth 30-million *reais* in São Paulo, generating a heated debate.[7] Several scientists of the area reacted to this project, arguing that it was a centralizing measure in distributing the scarce resources. Moreover, they stated that it was an action contrary to the recommendations from the PPA 2004-2007. It also was viewed as a serious questioning of the cooperative networks policy, that was previously evaluated as successful (cf. JC 2004).

As the research networks model prevailed, a year later the CNPq launched a new call to create research networks (Brazil Nano Program). Ten research networks were supported with R$27.2 million *reais* (US$

[7] This project is, again, a proposal from da Silva, who is returning with a high position to the MCT.

12 million) for four years from the PPA 2004-2007 and the Sectorial Funds.[8] This consolidated the initiative for network research that had been supported by the CNPq and, in addition to the development of new research, included goals for development and the improvement of infrastructure (cf. MCT 2006). In the context of an approximation of research policy to industrial policy, the research profile of these new ten networks reflects an orientation towards industrial application.

President Lula da Silva and the Minister of Science and Technology, Sergio Rezende, launched the National Nanotechnology Program in August 2005, with a budget of 71-million *reales* (US$ 31-million) for the 2005-2006 period. This program consolidated several of the previous initiatives, particularly the one from the PPA 2004-2007 and the orientation regarding nanotechnologies of the Industrial, Technological and Trade Policy. The additional funds allocated for this program doubled the originally estimated by the PPA 2004-2007 (cf. JC 2005). N&N were strongly set as a priority in national science, technology and innovation policy.

## 3 The Promises of Nanosciences and Nanotechnologies

What will the nanotech society be like? The articles analyzed offer us some visions of the future in which the ideas of revolution, benefits and growing efficiency stand out.

Thirty-seven articles on N&N specifically deal with the status of N&N in relation to former scientific development. Most of them (27) introduce N&N as being revolutionary, using expressions such as “technological revolution”, “change of paradigm”, “rupture” and “industrial revolution”. The other ten articles make use of more moderate terms, but they also highlight the newness of N&N, such as “state-of-the-art science and technology”, “new technologies”, “new field of research”.

Fifty-nine articles address the benefits of nanotechnologies (see Table 7). The main vision related to this revolution or cutting-edge technology is the promise of economic development. The benefits of nanomedicine for improving health and quality of life are also highlighted in the articles, as well as the potentials of nanotechnology for preserving the environment and reversing environmental degradation. A few articles refer broadly to “benefits for humanity” and even fewer state that nanotechnologies will help to reduce poverty.

**Table 7: Reports on N&N Published in JC, by Potential Benefits Resulting from N&N Research**

| | Number of Reports | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject | 9 | 15 | 18 | 17 | 59 |
| • Economic development | 9 | 13 | 10 | 12 | 44 |
| • Health and quality of life | 1 | 3 | 11 | 11 | 26 |
| • Preservation of the environment | 2 | 2 | 5 | 6 | 15 |
| • Benefits for humanity | 0 | 0 | 2 | 1 | 3 |
| • Poverty alleviation and inequality reduction | 0 | 0 | 0 | 2 | 2 |
| • Articles that do not broach the subject | 11 | 9 | 13 | 15 | 48 |
| **Total of articles** | **20** | **24** | **31** | **32** | **107** |

Note: More than one option is possible

Prepared by the author based on information from JC

An optimistic vision of the future arises in the articles, which stress improvements in economic, social and environmental conditions as a result of the development of N&N. We find in the JC neither futuristic utopias of human enhancement nor dystopias such as “gray goo” contaminating the planet. There is not even mention of the controversial radical perspective of molecular manufacturing proposed by Eric Drexler (cf. Drexler 1986).[9] Emphasis is placed on less futuristic subjects such as the efficiency of new products: better

8 The Sectorial Funds were created in 1999 with the objective of articulating the research demands of specific productive sectors such as petroleum, energy, hydraulic resources, mineral resources, transportation, information technology, health, aeronautics, agriculture, biotechnology and telecommunications.

9 The more radical visions of nanotechnology, such as that of Eric Drexler, foresee possible production by way of molecular machines capable of replicating themselves. He warned about the possibility of these machines breaking away from human control, leading to a “gray goo” which would contaminate the planet.

focused therapies, permanent monitoring of the body, extremely powerful computers, intelligent multi-functional clothing and more resistant and longer lasting materials. Table 8 shows the main areas for the application of nanotechnologies referred to in the articles: health, computers, new materials, agriculture and agribusiness are the most cited. In Figure 2 we provide some examples of the visions of efficiency in these areas.

**Table 8: Reports on N&N Published in JC, by Most Frequently Mentioned Fields for the Application of Nanotechnologies**

| | **Number of Reports** | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject* | 19 | 14 | 16 | 22 | 71 |
| • Medicine, Pharmaceuticals | 10 | 7 | 10 | 12 | 39 |
| • Computers | 10 | 6 | 7 | 9 | 32 |
| • New materials | 4 | 4 | 5 | 7 | 20 |
| • Agriculture and agro-industry | 3 | 7 | 0 | 2 | 12 |
| • Known consumer products with new features | 3 | 6 | 2 | 1 | 12 |
| • Devices for products and productive processes (sensors, catalysts, semi-conductors, etc) | 5 | 3 | 2 | 2 | 12 |
| • Cosmetics | 1 | 2 | 4 | 1 | 8 |
| • Chemical and petrochemical industry | 3 | 1 | 1 | 3 | 8 |
| • Car Industry | 2 | 1 | 1 | 3 | 7 |
| • Production and storage of energy | 0 | 1 | 3 | 3 | 7 |
| • Environmental remediation | 0 | 0 | 1 | 5 | 6 |
| • Telecommunication | 0 | 2 | 3 | 0 | 5 |
| • Textile and garment | 0 | 1 | 1 | 3 | 5 |
| • Articles that do not specify a field of application | 1 | 10 | 15 | 10 | 36 |
| **Total of articles** | **20** | **24** | **31** | **32** | **107** |

* Fields mentioned less than 5 times were excluded.

Note: More than one option is possible

Prepared by the author based on information in JC

| Health | |
|---|---|
| "A robot of microscopic proportions, seven times smaller than a red blood cell [can be used] to combat diabetes... the robot could be guided into the bone marrow to collect stem cells and take them to the pancreas, the organ responsible for producing insulin in the human body. [They could also] act within the blood vessels that surround the heart and carry out surgical procedures such as unblocking the arteries." (Nanorobotic medicine, JC e-mail 2609, 20 September, 2004, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=21662) | "Coupled with made-to-measure antibodies that adhere to cancer cells, tiny magnets the size of five millionths of a millimeter reach their goal. Using a magnetic field, they vibrate and heat up within the patient until they destroy the tumor. All the while, the neighboring tissues remain intact." (Researchers at the University of Brasilia will test nanomagnets against tumors, JC e-mail 2117, 11 September, 2002, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=4736) |
| **Computers** | |
| "…advances in the field of nanotechnology, such as electroluminescent polymers, mean that the bases for the design and commercialization of molecular computers are set… we are talking about the development of a computer that is a thousand times more powerful than those of today, not only in capacity to store data but also in speed and velocity of response." (Nanochemistry launches the bases for molecular computers, JC e-mail 1986, 06 March, 2002, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=1046) | "One of the nearest projections to be implemented in computers or electronic gadgets in the next twenty years is the use of metallic nanofibers to connect components of a chip or an integrated circuit board. [The purpose is] to facilitate the miniaturization of circuits even more and make processing capacity faster... [Now] we have ceramic nanotapes ... [which] have the advantage of not merging like metallic nanofibers... and can stand ten times more density than a gold nanofiber..." (Powerful connections: Ceramic nanotapes are candidates to connect circuits and transistors, JC e-mail 2811, 14 July, 2005, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=29801) |
| **New Materials and Products with New Features** | |
| "Plastic food packaging that changes color when food has gone off. Cars whose paintwork absorbs solar energy to recharge the battery. Windows that turn sunlight into energy. These innovations and many others which promise to conquer the market in a short time are the fruits of nanotechnology. Some of them will be exhibited at Nanotec Expo 2005, the first large-scale nanotechnology event in Latin America." (Brazil has 120 nanotechnology patents. JC e-mail 2802, 01 July, 2005, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=29474) | "Scientists have produced the most resistant fibers known to man by using carbon nanotubes. In the future… it will be possible to weave these fibers and transform them into tissues capable of storing energy, picking up radio signals or working as sensors. Use your imagination and dream of a bullet proof shirt that plays MP3 files and receives your cell phone calls. An even more realistic application would be light armor that would also supply electrical energy for the radio and other equipment that a soldier requires." (The revolution of nanotube fibers, JC e-mail 2329, 28 July, 2003, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=11543) |
| **Agriculture and Food** | |
| "Very thin film, whose thickness may be as little as two or three molecular layers are used to protect fruit or slices of fruit. The fruit could now last for as long as one or two weeks because the film slows down the ripening process and protects the fruit from decomposing microorganisms." (Embrapa earmarks four million reais for nanotechnology, JC e-mail 2998, 18 April, 2006, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=36857) | "... now being developed are.... fertilizers that can release their main component only when coming into contact with the weed it is directed at… we have also researched herbicides that will release poison only when coming across the fungus it is made to combat." (Embrapa will have a nanotechnology laboratory, JC e-mail 3157, 06 December, 2006, http://www.jornaldaciencia.org.br/Detalhe.jsp?id=42886) |

**Figure 2: What Does Nanotechnology Have in Store for Us? Examples**

Prepared by the author from information in JC

These optimistic visions are set in the immediate future, a period that expects a huge surge in the nanoproducts market – Lux Research (cf. LR 2006) estimates that the market for products containing nanotechnologies in 2015 will be worth US$ 2.9 trillion. In 35 of the 50 articles that broach the time frame for the development of nanotechnology, the argument is made that this development has already begun or will explode during the next ten years.

# 4 Economic, Social and Ethical Implications and Potential Risks

A third of the articles (34) published in the JC from 2002-2005 touch on an aspect of the economic, social and ethical implications and the potential risks of nanotechnologies (see Table 9).

**Table 9: Reports on N&N Published in JC in Order of Implications of the Development of Nanotechnology**

| | Number of Reports | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject | 7 | 8 | 11 | 8 | 34 |
| • Changes in conditions for production and competitiveness | 3 | 5 | 3 | 4 | 15 |
| • Risks to health and the environment | 0 | 2 | 8 | 5 | 15 |
| • Greater social inequality | 0 | 1 | 2 | 3 | 6 |
| • Changes in way of life | 0 | 1 | 3 | 1 | 5 |
| • Ethical dilemmas | 0 | 1 | 1 | 2 | 4 |
| • Fall in traditional exports | 0 | 1 | 0 | 1 | 2 |
| • Risks to workers in laboratories and industry | 0 | 0 | 1 | 0 | 1 |
| • Articles that do not broach the subject | 13 | 16 | 20 | 24 | 73 |
| **Total of articles** | **20** | **24** | **31** | **32** | **107** |

Note: More than one option is possible

Prepared by the author based on information in JC

Changes in the conditions of production and productivity as a result of the diffusion of nanotechnologies is one of the subjects that appears most frequently during this whole period, mentioned in 15 articles. However, the importance given to the economic implications is quite limited when compared to the perspectives of economic development as the main benefit of nanotechnologies put forward in 44 articles. The articles do not allude to the potential adverse results of these economic changes, for instance company closures and job losses. Nor do they mention any actions to avoid or face these problems. Thus, the point of view prevails that economic development, spurred on by nanotechnology will not cause any major upsets.

The potential risks to health and the environment, also mentioned in 15 articles, are most frequently addressed in 2004 and 2005. Two events introduced the theme of risks in 2004: the foundation of the Nanotechnology, Society and Environment Network in Brazil and the publication of the report of the Royal Society and the Royal Academy of Engineering (cf. RS&RAE 2004). The subject is dealt with more frequently by social scientists, most of them members of the Nanotechnology, Society and Environment Network, than by scientists from the natural sciences.

Other matters that are often mentioned in the literature on the implications of nanotechnologies (cf., f.i., Invernizzi/Foladori 2005; MI 2005, 2007; Moor/Weckert 2004; RS&RAE 2004; Salamanca-Buentello et al. 2005; UNESCO 2006, 2007; Wood et al. 2003), such as ethical dilemmas, possible widening of the poverty gap, fall in traditional exports and risks to laboratory and industrial workers are scarcely referred to in the articles analyzed.

In short, there is little concern over the economic, social and ethical implications of nanotechnology in the articles of the JC. Among the scientists who are involved in research in the field, there is no significant concern over such matters. This is in line with public policy for N&N research which does not consider any assessment of these implications.[10]

Throughout the debate on the implications and risks of nanotechnology, as it was with previous technologies, demands have been made by a number of groups in society for more information and public participation. Demands have also been made to adopt precautionary measures and regulation of nanotechnologies. From the selection of some debated topics that stand out in the literature cited above, listed in Table 10, we

[10] In 2007, the MST published the Plan of Action 2007-2010 entitled "Science, Technology and Innovation for National Development", which includes a Plan of Action for Science, Technology and Innovation for Nanotechnology among the fields that are considered strategic. This document sets out for the first time in public policy the need to "establish policies on the ethical questions of nanotechnology and the social impact of the use of nanotechnology-based products" (MCT 2007, p. 144).

sought to map out the importance given to these matters in the JC reports. We came across very scanty references in only 11 articles. The need to provide information about N&N to the public is addressed by 7 articles, 4 of them refer to public participation, and another 4 articles discuss regulation issues.

**Table 10: Reports on N&N Published in JC, by Reference to Actions Concerning the Potential Implications and Risks of Nanotechnologies**

| | **Number of Reports** | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject | 0 | 1 | 6 | 4 | 11 |
| • Public information | 0 | 1 | 4 | 2 | 7 |
| • Regulation | 0 | 0 | 0 | 4 | 4 |
| • Public participation | 0 | 0 | 2 | 2 | 4 |
| • Precautionary measures | 0 | 0 | 3 | 0 | 3 |
| • Moratorium | 0 | 1 | 1 | 0 | 2 |
| • Articles that do not broach the subject | 20 | 23 | 25 | 28 | 96 |
| **Total of articles** | **20** | **24** | **31** | **32** | **107** |

Note: More than one option is possible

Prepared by the author based on information in JC

Concerning public information, it is worth mentioning the Nanoaventura (Nanoadventure) initiative for science divulgation that is reported in three articles. Developed by the Science Explorer Museum in Campinas, São Paulo State, it was used as a traveling exhibition throughout 2005, with over 25,000 visitors in the cities of Rio de Janeiro, Campinas, São Paulo and Porto Alegre. This project, coordinated by Marcelo Knobel, a physicist at the University of Campinas (Unicamp) was developed by professors and researchers at the Unicamp University and the National Synchrotron Light Laboratory (LNLS).

One matter that stands out due to its virtual absence in the articles analyzed is references to visions of nanotechnology from other actors outside of the scientific community. Only 9 articles out of a total of 107 allude to non-governmental organizations or manifestations by the public concerning nanotechnology. Thus, for instance, it is notable that very few comments are made in the JC about a very significant event that took place in 2003, when the ETC Group called for a moratorium on nanotechnology, pointing out possible risks to health and the environment at the World Summit on Sustainable Development held in Johannesburg. This call was highly controversial. However, in the JC, it was only referred to in one report. References to potential conflicts between science and the public over N&N is also scarce – a total of 9 articles over the period. This is significant, given that at least two scientific controversies have been the object of conflict between science and the public in Brazil in recent years: genetically modified organisms and stem cell research.

Among the few references to organized social groups, we found some that attempt to dismiss the capacity or legitimacy of NGOs to voice their opinions on nanotechnology. One researcher in the field of biological sciences, for instance, recognizes the existence of the risks of nanoparticles to human health and the environment. He says these risks are low and avoidable and speaks of the need to inform the public in order to "face activists who fight, armed only with popular fantasies, [and who] are organized against this type of science, demanding a moratorium" (Garcia 2004). Another scientist, Henrique Toma, a chemist from the University of Sao Paulo, informs us during an interview that there are already cosmetics with nanoparticles on the market but that the companies who make them do not make this public "so that they won't suffer with NGOs" (Geraque 2004). It is necessary to note that both emphasize the importance of scientific information for the public, but they do not recognize the legitimacy of social movements' opinions on technologies, their implications and their potential risks.

# 5 Legitimizing the Field

The general picture on N&N presented by the articles analyzed is one of a revolutionary field that is about to take off, with a huge potential for benefits, and a fabulous market being developed over the next few years. Since little attention is paid to the economic, social and ethical implications and the potential risks of nanotechnologies, the visions of the nanotechnological future presented by the JC are optimistic and mostly unproblematic. Undoubtedly, besides expressing the enthusiasm of scientists for a new field of research that opens up new and exciting challenges, these visions seek to promote N&N as an interest of the scientific community that reads the JC, justifying its relevance for technological, economic and social development of the country. To legitimize the field of research better, scientists and policy makers stress these visions by means of three arguments: opportunity, necessity and viability.

N&N is frequently referred to in these articles as a change in the scientific and technological paradigm or as a new strategic field of science that will open up a historic *opportunity* for Brazil (see Table 11). This perspective has been clearly translated into a justification for the PDN&N, which supports this point of view when it states that: “in an imminent breaking of paradigms due to nanotechnology and nanosciences (N&N) we are now faced with a unique opportunity to join this new era along with developed countries” (MCT 2003, p. 8).

**Table 11: Reports on N&N Published in JC, in Order of Main Reasons to Justify Support for Nanotechnology Research in Brazil**

| | Number of Reports | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject | 8 | 12 | 10 | 11 | 41 |
| • To develop competitiveness to enter the global market | 6 | 7 | 6 | 7 | 26 |
| • Emerging science/strategic field/change of paradigm | 5 | 7 | 3 | 5 | 20 |
| • To train qualified human resources for the country to be able to develop nanotechnologies | 0 | 2 | 2 | 0 | 4 |
| • To meet local social needs | 0 | 1 | 0 | 3 | 4 |
| • Brazil must not fall behind in technology again | 0 | 2 | 1 | 0 | 3 |
| • To gain technological autonomy | 0 | 0 | 1 | 2 | 3 |
| • Sustainable development | 0 | 0 | 1 | 0 | 1 |
| • Articles that do not broach the subject | 12 | 12 | 21 | 21 | 66 |
| **Total of articles** | **20** | **24** | **31** | **32** | **107** |

Note: More than one option is possible

Prepared by the author based on information in JC

A window of opportunity opens onto a huge market that Brazil can participate in if it develops its competitiveness in N&N. Making Brazil competitive is the central argument that unites scientists and policy makers to justify the need for a policy on nanotechnology. This is translated, in the policy for the sector, into ambitious goals for the market which have already been set out in the PDN&N, proposing the goal of raising Brazilian participation in the nanotechnology market to US$30 billion by 2020, which will account for 3% of the forecasted world nanoproduct market for the same period (cf. Oliveira 2003).

Other arguments such as avoiding technological gaps, guaranteeing technological autonomy, promoting sustainable development and meeting social needs at a national level are only marginally utilized to legitimize the field of research.

From opportunity comes the *necessity* to develop aggressive policies and investing resources because if this is not done, Brazil will remain outside of this new paradigm in which so many countries are investing so quickly. Metaphors such as “we can’t miss the bus” or “we’ve got to catch this wave” are commonly used. One researcher wonders whether Brazil will take the historic opportunity it has today in this field and claims that this depends on the government and industry, arguing that “If this decision is not taken, we miss the bus that will make us go down in history as has happened to us before, for example, in the field of microchips” (Moysés Nussenzveig, quoted by Montserrat 2003). The physicist Marcelo Knobel voices a similar opinion: “With a clear policy on nanoscience and nanotechnology, we will be able to compete with other countries as their peers, but we need to hurry up because these other nations have already started singling out this field to get a head start” (Marcelo Knobel, quoted by Da Silveira 2003).

Lastly, the argument of national *capacity* for the development of N&N is mentioned in almost half of the articles and becomes increasingly important as time goes by (see Table 12). It is argued in these articles that the cooperative research networks in N&N, created by the CNPq in 2001, gathered highly qualified and productive human resources capable of advancing world-class research and pushing innovation towards the promising nanoproduct market. The capacity for research infrastructure is also frequently highlighted and considered to be the best in Latin America. The fruits of the research, which begin to be shown in the form of scientific articles, patents, prototypes, participation in international events, etc., are reported in a number of articles as proof of the productivity of national research.

Likewise, mention is made of the growing relevance of Brazilian science within world science, which in the case of N&N has seen above average growth. The physicist Cylon G. da Silva points out in an interview that while Brazilian participation in world science as a whole is 1.44%, when it comes to nanotechnology this figure rises to 2.9% (cf. Teixeira 2004).

**Table 12: Reports on N&N Published in JC, in Order of Conditions for Brazil to Develop Nanotechnologies**

| | **Number of Reports** | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject | 5 | 11 | 11 | 18 | 45 |
| • Quality/Excellence of research in the Latin-American and world context | 2 | 9 | 9 | 15 | 35 |
| • The fruits of the research have begun to appear | 0 | 7 | 2 | 6 | 15 |
| • There are segments with high potential for N&N development | 3 | 1 | 1 | 3 | 8 |
| • Adequate S&T policy | 2 | 1 | 0 | 4 | 7 |
| • Articles that do not broach the subject | 15 | 13 | 20 | 14 | 62 |
| **Total of articles** | **20** | **24** | **31** | **32** | **107** |

Note: More than one option is possible

Prepared by the author based on information in JC

Few articles, a mere 26, record the existence of obstacles against the development of N&N in the country (see Table 13). The obstacle that is referred to most, the lack of resources invested in comparison with the high cost of N&N research, is the almost natural result of the demands of scientists to place more priority on this field in the overall budget for S&T.[11]

**Table 13: Reports on N&N Published in JC by Main Difficulties Facing the Development of Nanoscience and Nanotechnology in Brazil**

| | **Number of Reports** | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | Total |
| Articles dealing with the subject | 4 | 10 | 8 | 4 | 26 |
| • High cost/Insufficient infrastructure and human resources | 3 | 8 | 7 | 2 | 20 |
| • Weak link between research and the productive sector | 2 | 3 | 3 | 3 | 11 |
| • Inadequate S&T policy | 0 | 3 | 1 | 1 | 5 |
| • Articles that do not broach the subject | 16 | 14 | 23 | 28 | 81 |
| **Total number of articles** | **20** | **24** | **31** | **32** | **107** |

Note: More than one option is possible

Prepared by the author based on information in JC

The second obstacle, mentioned in 16 articles, is much more significant as it involves the main goals of the policy for N&N in the country: the weak link between research and the productive sector. This relevant issue deserved little attention by scientists and policy makers in the JC, particularly considering that during the same period of time the Innovation Law,[12] oriented to stimulate the relationship between research and innovation by the productive sector, was largely discussed and finally approved.

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[11] The resources allocated to S&T account for 0.98% of GDP, although the Lula government had originally proposed to double this level of investment.

[12] The Innovation Law, approved in December 2004, focus on mechanisms to bridge the scarce relationship between research institutions and the productive sector in Brazil.

## 6 Main Actors

Through our analysis we have found that there are some actors who have an outstanding role in the promotion of certain visions concerning nanotechnology. Among the Brazilian actors, physicists are by far the most quoted in articles about N&N in the JC, followed by engineers and chemists, and researchers in the field of biology and health (see Table 14).

Only six researchers in the social sciences and humanities fields are authors or quoted sources in articles throughout the period. Two of them held posts in the government as policy makers and the other four research the social implications of N&N. Even though their scientific associations are members of the Brazilian Society for the Progress of Science, researchers from the social sciences and humanities in general appear less frequently in the JC, and this is corroborated in the case of articles about N&N.[13] However, this narrow presence in the JC, along with the low number of articles that deal with the social implications of N&N, may also be an indicator that there are still very few scientists in the social sciences and humanities fields who are involved with these matters.

**Table 14: Researchers on N&N and Policy Makers Quoted in Articles or Authors of Articles in JC, by Area of Training**

| | **Number of researchers and policy makers** |
|---|---|
| Physics | 30 |
| Engineering | 13 |
| Chemistry | 13 |
| Pharmaceuticals, biology and medicine | 10 |
| Humanities and social sciences | 6 |
| No information available | 3 |
| **Total** | **75** |

Prepared by the author based on information contained JC and the Currículos Lattes data base of the CNPq (cf. http://lattes.cnpq.br/index.htm)

This predominance of the viewpoints of researchers in the fields of physics, natural sciences and engineering is translated in the preponderance of visions of social and scientific progress that we qualified before as "not problematic". Such visions tend to associate, in a linear fashion, new technologies, greater competitiveness, economic development and social welfare. As they do not take into account the more complex relationship between science, technology and society, these visions are linear visions of progress.

## 7 Comments and Reflections

Over the last seven years, a wide-ranging N&N policy has been consolidated in Brazil, making the country one of the leaders in Latin America by launching the first national program for the development of nanotechnology in the region. This process was not an isolated government initiative or of few renowned scientists. By analyzing the visions of N&N that researchers in the field have spread in the JC, a vehicle of the much respected Brazilian Society for the Progress of Science, we see the active involvement of a large group of researchers who have worked to outline this policy.

Some prominent researchers have held important positions as policy makers in the Ministry of Science and Technology while others have worked as advisers in groups which the Ministry has designated to study specific matters pertaining to the process of preparing this policy, directly influencing the final form it would take. Other researchers have been less directly involved but have been instrumental in making the new field of research public by speaking of its potential for the development of the country, by characterizing it as a strategic field that Brazil could not afford to be left out of. There can be no doubt that, through their visions of N&N, researchers have made the field legitimate.

We have seen that, through their articles in the JC, the researchers, despite some serious debate over the allocation of research funds, have been highly unified in their visions of N&N. The superiority and greater effectiveness of future nanotechnologies and nanoproducts that are already available, and the possibilities

[13] I make this statement merely as an avid reader of the JC, without any accurate figures.

that the country will have to enter new markets have been the strongest arguments used to connect nanotechnologies with economic development and improved standards of living. These promises were introduced as viable by emphasizing that the country can count on a significant and productive group of researchers, who are making the country stand out in international scientific production in the field of N&N.

Considering the convergence of the visions spread by researchers and the justification and goals outlined by the policies for the sector, together with the definition of N&N as a strategic area in science, technology and innovation in Brazil, we can state that these visions were successful in legitimizing the field and ensuring research funds.

In the JC, the number of articles portraying perspectives outside these dominating visions was very low. Through comments on international reports like that of the Royal Society, in 2004, and references to seminars organized by the Network of Nanotechnology, Society and the Environment there appear subjects such as the social, economic and ethical implications and the risks that may result from nanotechnologies. However, these viewpoints carry relatively less weight in the articles as a whole and the same can be said of their impact on N&N policy. And even more significant, perhaps, is the fact that their appearance did not spark any dialog or controversy between the visions on progress held by nanotechnology researchers and the visions of a society that will be affected in many ways by the diffusion of nanotechnologies introduced by the researchers than analyze their social implications.

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# Florida – Adequate Forecasting Scenarios

*Gordon L. Nelson*

## 1 Growth of Florida

The State of Florida is the fourth largest state of the United States in population, with over 18 million residents, behind California (36.5 million), Texas (23.5 million), and New York (19.3 million). The population growth of Florida since 1950 is nearly a factor of seven. Projected growth from 2000 to 2010, official census years, is 25%. The population projection for 2060 is 36 million. The Florida economy is $729 billion and is expected to grow to $3.7 trillion in 2036 (cf. Forecast 2007). As a result of this growth Florida has elaborate planning processes, both official and unofficial. Each county, the next smaller governmental division to a state, has a "Comprehensive Plan". Actions by county government must be consistent with its comprehensive plan. Growth in population impacts multiple areas of life. Transportation, schools, housing, shopping, jobs, recreation, to name but six, are all impacted by population growth. Public processes must anticipate needs and plan for necessary future infrastructure. As citizens, as voters, as academics, we are all part of the process.

Growth of 25% in ten years is not the norm in the United States or in Europe. Hungary, our partner in this Forum, has a population of 10 million in an area of 35919 sq. mi. (93,030 sq. km) (versus 65,758 sq. mi. (170,313 sq. km) for Florida). Thus Florida and Hungary have a similar population per unit area. However, the population of Hungary declined 18000 in the period of January-May 2007. There were 39,000 births (down 3%) and 57,000 deaths (up 2.3%) in Hungary during this period. Marriages were 12,000, down 10% from a year earlier. At the end of World War II the population of Hungary was 9.8 million. Projections have the population of Hungary falling below 10 million in 2011 and to be at 8.7 million in 2050. The population of 0-19 year olds may halve over the next 50 years. By 2050 the working age population of Hungary may be 75% of that today. By that time perhaps 36% of the population will be over 65. Immigration is modest.[1]

Forecasting is at the heart of good planning. The resulting issues are social, economic, political, infrastructure, and beyond. In the absence of good forecasts good decisions are not possible. Are there changes occurring? How long does it take to recognize change? Are those changes transitory or permanent? Have those scenarios been included in the forecasting process? That is the topic of this report.

## 2 Planned (Smart) Growth

As noted, some projections have Florida's population reaching 36 million by 2060. Assuming current development patterns, roughly 7 million acres (2.8 million hectares) will be converted from rural to urban of Florida's 38.3 million acres (15.5 million hectares). This would include 2.7 million acres (1.1 million hectares) of existing agricultural lands and 2.7 million acres (1.1 million hectares) of native/wildlife habitat. Urban development would go from 6 million acres (2.4 million hectares) to 13 million acres (5.3 million hectares). Counties like my own, Brevard, would be built out before the end of that period. There would be continuous urban development from Ocala to Sebring and from St. Petersburg to Daytona Beach. The I-75 and I-4 corridors (interstate highways) would be fully developed. Thus the pressure is for more sustainable development.[2] There are multiple study efforts. One such effort is MyRegion.org. The MyRegion.org effort spent $1 million over 18 months to develop a shared 50 year vision for the seven counties of east central Florida. The work involved numerous public, private, and civic organizations, and some 20000 individuals through meetings and questionnaires. The author attended both meetings and submitted a questionnaire.

Central Florida's population was 400,000 in 1950, 1.6 million in 1980, and 3.5 million in 2005. It is projected that Central Florida will double in population from 2005 to 2050, to 7 million people. The region's

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1 Cf. www.infoplease.com. Hungary; Population Continues to Fall. In: Budapestsun.com, July 24, 2007; The Downward Population Spiral. In: Budapestsun.com, October 2, 2003; Government Looking to Boost Population. In: Budapestsun.com, March 30, 2002.

2 Cf. Florida in 2060: Not a Pretty Picture? Executive Summary. 1000 Friends of Florida. December 2006. – URL: http://1000fof.org.

population is diverse, representing a broad mix of cultures, races, ethnicities, and ages. The region created one million new jobs between 1980 and 2005. The economy blends traditional strengths in agriculture, tourism, space, and defense with emerging industries related to aerospace, photonics, and life sciences. The income brought into the region has nearly tripled, from $37 billion in 1980 to $107 billion (in 2005 dollars) in 2005.[3]

Given the current pattern of development the following issues are foreseen:[4]

1. The region will consume as much land in 45 years – 670,000 hectares – as has been developed over the last 440 years.
2. About 89,000 additional hectares of irreplaceable environmental lands and wildlife habitats will be consumed.
3. Most new building will be single-storey, single family homes on 1/3 to 1/2 acre lots (~2000 square meters).
4. Residents will continue to move further away from where they work, resulting in increased commute times and less time at home. The majority of new money spent on transportation will be spent on new roads. Even so, the average person will spend more than 90 minutes per day commuting, compared to about 20 (45-50 GN) minutes today.
5. The volume of carbon monoxide and other green house gasses produced in the region will more than triple, contributing to a decline in air quality and public health and increased contributions to global climate change.
6. Water consumption will increase by 70%, depleting the Floridan aquifer and raising questions about the availability of water for future generations.

In its final report, "How Shall We Grow", August 2007, My Region.org elucidated six regional growth principles:

1. Preserve open space, recreational areas, farmland, water resources, and regionally significant natural areas.
2. Provide a variety of transportation choices.
3. Foster distinct, attractive, and safe places to live.
4. Encourage a diverse, globally competitive economy.
5. Create a range of obtainable housing opportunities and choices.
6. Build communities with educational, health care, and cultural amenities.

The preferred alternative is a different approach to growth, in which the region preserves its most precious environmental and agricultural lands, focuses development in urban centers, and connects these centers with transportation corridors that provide more choices for how people travel, a more European lifestyle. Implementation requires some 86 municipalities and 7 counties to work together, to develop a regional "greenprint", to develop regional transportation corridors, to unleash creativity of developers and others, and to measure progress, inspect and improve over the 45 year timeframe. The report "How Shall We Grow" was followed by a much more detailed "Comprehensive Economic Development Strategy", September, 2007.[5] All of the above is predicated on a consistent pattern of growth, which currently provides the economic underpinning of development. Similar studies exist for other regions of Florida and for the state as a whole, with similar results.[6] But how good is the forecast for continued growth?

## 3 Issues Challenging Growth

In 2004 four hurricanes hit Florida (Charlie, Francis, Jeanne, Ivan) covering most of the state. Statewide damage totaled $24 billion. In my county, Brevard County, alone, damage was $1 billion. Most counties of the state experienced some damage. While damage is now largely repaired, the four hurricanes of 2004 and Wilma in Florida and Katrina in Mississippi and Louisiana in 2005 raised hurricane awareness in other parts of the county. There were certainly Florida people who said that they did not wish to go through a

[3] Cf. How Shall We Grow? In: MyRegion.org, August 2007.
[4] Cf. How Shall We Grow? In: MyRegion.org, August 2007.
[5] Cf. East Central Florida. Comprehensive Economic Development Strategy. MyRegion.org report, September, 2007.
[6] Cf. Charting the Course: Where is South Florida Heading? Report, March 2006. – URL: http://www.soflo.org; Thorner 2007.

hurricane experience again. For Francis and Jeanne I evacuated to St. Petersburg on the other side of the state. While I experienced little damage, on return the city was a “war zone” with National Guardsmen, with machine guns, in the streets directing traffic. One follow on result of the 2004 and 2005 hurricane seasons is that some major insurance companies such as Allstate and State Farm have dropped thousands of Florida customers for homeowners insurance. Many homeowners have had to scramble for alternatives or use the State as the insurer of last resort. Even those who have not had to find a new carrier have seen there coverage increase in cost two or three fold. Fear of hurricanes and cost of hurricanes is the first issue.

The second issue involves the subprime mortgage financial crisis. The origin of the subprime financial crisis was the sharp rise in foreclosures in the subprime mortgage market that began in the United States in 2006 and became a global financial crisis in July 2007. Rising interest rates increased the monthly payments on newly-popular adjustable rate mortgages. Many sub-prime mortgages were in fact “balloon” mortgages, whose payments were fixed for two years and then rise sharply to a higher variable rate (in some cases double). This coupled with property value declines (20%-30% in some markets) as the US housing market bubble collapsed, left homeowners unable to meet financial obligations and lenders without a means to recoup their loses, since the property was now worth less than the mortgage alone. This resulted in a credit crunch threatening the solvency of a number of marginal private banks and other financial institutions. This has been associated with declines in the stock markets worldwide, several hedge funds becoming worthless, coordinated national bank interventions, contraction of retail profits, and bankruptcy of several mortgage lenders.

Subprime lending is a general term that refers to the practice of making loans to borrowers who do not qualify for market interest rates because of problems with their credit history or the ability to prove that they have enough income to support the monthly payment on the loan for which they are applying. Down payments may be less as well. Subprime loans or mortgages are risky for both creditors and debtors because of the combination of high interest, bad credit history, and murky financial situations often associated with subprime applicants. Thus far less than 1% of subprime mortgages have been successfully renegotiated and thus avoid foreclosure. Each quarter 450,000 US mortgages will face sharply higher interest rates over the next two years. Subprime debt is repackaged into wider debt offerings called collateralized debt obligations, which are then resold on the global market. Total loses in the financial sector could exceed $400 billion. As mortgages are bundled and sold between institutions, mortgages are eventually held by bond holders around the world.[7]

It is reported that there are 7.2 million households in the US with subprime mortgages, and more that 14 percent of those are in default. It is projected that 20% of those loans issued in 2005 and 2006 will end in foreclosure, with 2.2 million families loosing their homes. Ohio, California, and Florida are the states most affected. Two metropolitan areas with the largest property value declines are Tampa (11.1% since September 2006) and Miami (10%). Of the ten metro areas with the highest rates of foreclosure two are in Florida, Fort Lauderdale and Miami, with one foreclosure per 48 households and 60 households respectively. Foreclosures rose 90% and 43% respectively from the first to second quarter of 2007 in these two markets (cf. Christie 2007a, 2007b).

In Brevard County, Florida, as of the end of August, 2007, there were 1,300 homes in the process of foreclosure compared to 281 for the same period last year. This year 809 homes have been sold at court-ordered auctions, or about one-sixth of the 4,675 properties sold on the open market. That compares with 301 total foreclosure sales for all of 2006. Speculative buying was also a factor. Of 12,000 purchase mortgages inked in Brevard in 2002, just 17% were for non-owner occupied dwellings. By 2005 that number was 31% of the more than 20,000 loans issued. People were trying to cash in on rapidly rising prices, which more than doubled from 2000 to 2007. In Brevard the number of subprime loans went from 1,600 in 2004 to 5,000 in 2006. In all of Florida by October, 2007 more than 5% of subprime loans were in the process of foreclosure versus 0.6% of prime loans, almost a factor of ten difference in risk. An additional 14% of subprime loans were at least 30 days delinquent compared to under 3% for prime loans. There are some 7,692 single-family homes for sale in Brevard County (October) versus 4,206 at the same time in 2006. Building permits for new-single family homes are running more than 50% below last year statewide. In Brevard County building permits are 34% in 2007 of what they were in 2005. Home prices are projected to fall 25% from 2006 through 2008. Interestingly, from 2000 to 2007 the number of real estate licenses grew seven fold in Brevard County, from 1,118 to 7,747. One in 56 adults in Brevard County had a real estate license,

7 Cf. Subprime Mortgage Financial Crisis. – URL: http://en.wikipedia.org/wiki/Subprime_mortgage_crisis.

one real estate agent per house for sale in Brevard County. Clearly, the majority are now looking for other work (cf. Blake 2007; McCarthy 2007; Vittner 2007).

With the rapid rise in home values, as homes sold, they took on the new value for property tax purposes. However, Florida has a "Save Our Homes" constitutional amendment which limits increases of assessed valuations of existing "Homestead" property to 3% per year. Thus a substantial tax differential resulted between owner occupied existing homes and recently sold homes, perhaps sited next to each other. This doubling of property taxes plus the doubling to tripling in insurance premiums resulted in Florida homes no longer being affordable. Florida property which had been below the national average (see Figure 3) for some 15 years had by 2006 become 20% higher than the national average. Florida home affordability (price, mortgages, taxes, and insurance) is the second issue along with mortgage availability (cf. Vittner 2007).

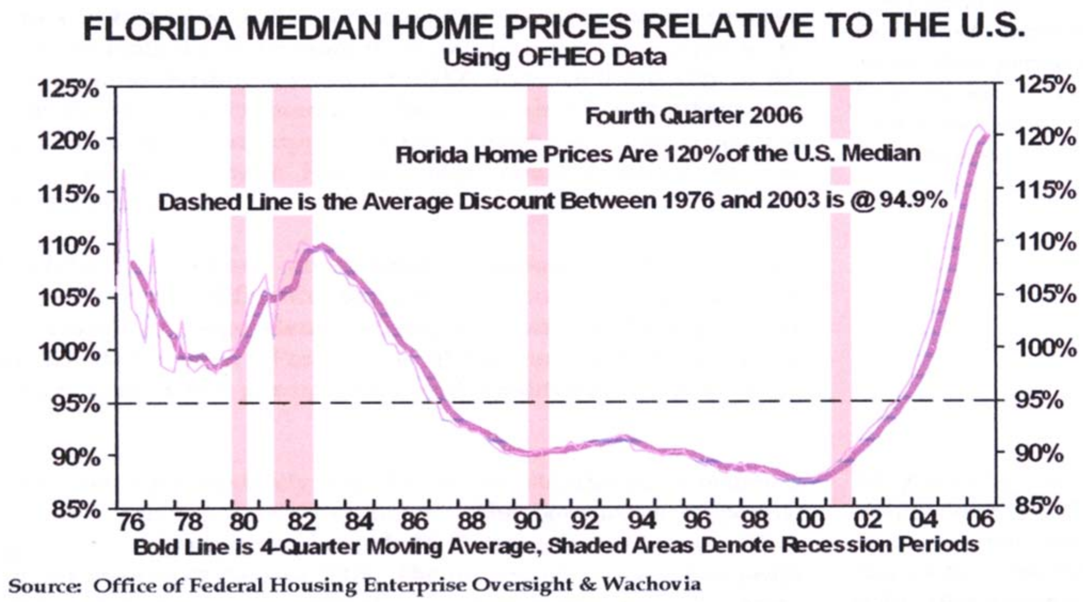


**Figure 3: Florida Median Home Prices Relative to the U.S.**

Source: Vittner 2007

Governor Charles Crist called a second special session of the Florida Legislature in October, 2007 to deal with a $1.1 billion budget shortfall brought on by flagging tax collections (sales and real estate transfer tax, Florida does not have an income tax) against a $71 billion budget. A further decline of $1.08 billion is forecast in the current fiscal year, but this is against a reserve of $1.8 billion. For fiscal year 2008-09 revenues are expected to fall about $1.5 billion short of previous projections. While this is only 2%, the numbers are still in billions of dollars. The Florida Legislature will need to deal with another $1 billion budget reduction at its March, 2008 session. Housing is clearly related to other markets. In 2006 16 percent of new car purchases in Florida were made with home equity loans versus only 7% nationally. Families have relied on cash from mortgage refinancing in an up market coupled with low interest rates to finance major purchases. In spring 2006 9 of 20 metropolitan areas that saw the sharpest home price appreciation in the US were in Florida. Consumer confidence in Florida has dropped markedly, especially willingness to buy expensive items. The consumer confidence index was 77 in November versus 93 in 2006 (cf. Ash 2007; Balancia 2007; Cotterell 2007; Goodnough 2007).

## 4 Schools

For the fall of 2006 the Florida Department of Education had forecast a 48,853 (51,000 average 1989-2004) increase in the school population (K-12). It turned out to be only 477. There are 2.64 million students in Florida schools. The 2006-2007 actual was the largest anomaly in DOE student projections in 20 years (see Figure 4). Twenty-nine of 67 counties showed declines in enrollment, including in 8 of the 10 largest school districts. The top ten school districts declined 19,000 students. Preliminary data indicate similar results for the 2007-2008 school year (see Table 15).

**Table 15: Annual Enrollment Change for Florida's 10 Most Populous Districts, Fall 2006**

| Annual Enrollment change for Florida's 10 most populous districts, Fall 2006 State aid $ 7,300 | | | | |
|---|---|---|---|---|
| District | 0506 Fall Count | 0507 Fall count | Annual change | Preliminary Δ 2007 |
| MIAMI-DADE (4th largest in US) | 366,316 | 357,766 | -8,550 | -8,600 (-2.4%) |
| BROWARD | 272,978 | 264,169 | -8,809 | -5,192 |
| HILLSBOROUGH | 194,607 | 194,423 | -184,000 | -442,000 |
| ORANGE (12th largest in US) | 176,788 | 175,865 | -923,000 | -1,072 |
| PALM BEACH | 175,888 | 172,413 | -3,475 | -2,036 |
| DUVAL | 129,118 | 127,842 | -1,276 | -1,000 |
| PINELLAS | 113,142 | 110,941 | -2,201 | -3,100 |
| POLK | 89,864 | 93,192 | 3,328 | 1,000 |
| BREVARD 5.1.2 Billion Budget | 76,085 | 75,609 | -476,000 | -4,400 |
| LEE | 75,979 | 79,304 | 3,325 | 2,500 |
| | | | **-19,241** | **-18,382** |

Source: Balancia 2007

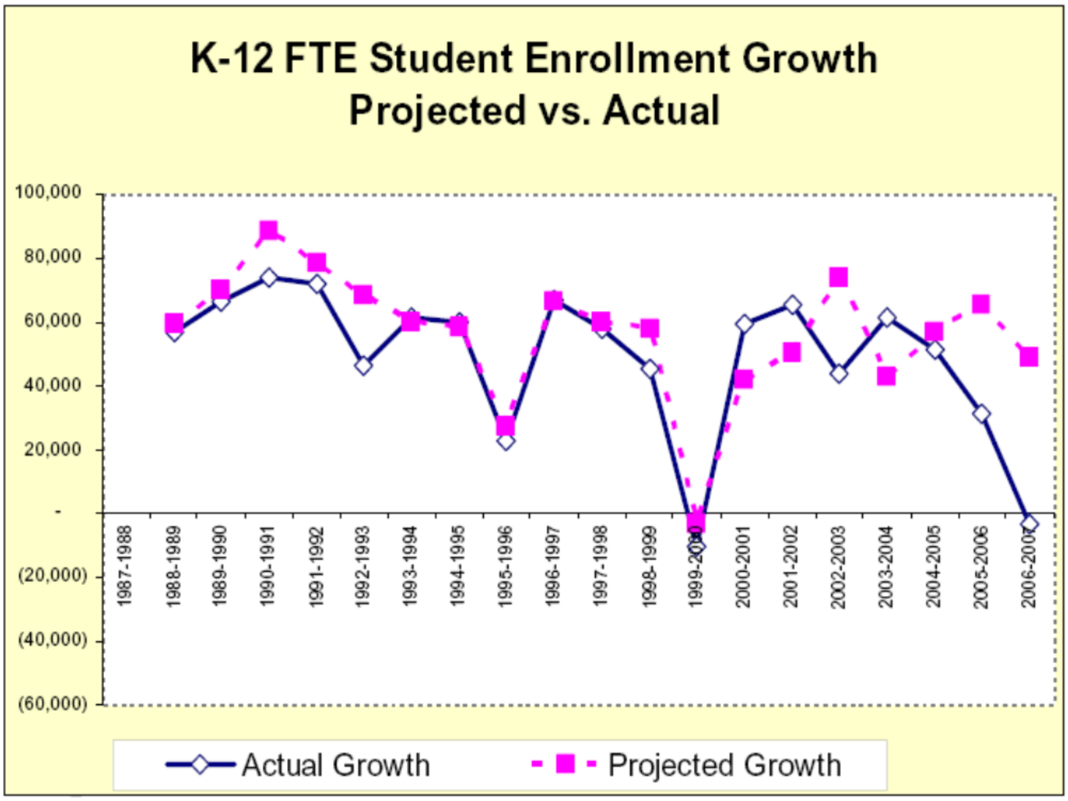


**Figure 4: K-12 FTE Student Enrollment Growth Projected vs. Actual**

Source: Office of Federal Housing Enterprise Oversight & Wachowia

Polk County, the largest school district to show an increase, had a 1% increase in 2007-2008 against a 3.1% expectation of growth (cf. Dukes 2007). Because of the lower than expected growth some school districts are beginning to delay or cancel building projects. State aid ($19.3 billion) is distributed to school districts on the basis of the number of students (FTE), about $7,300 per student (cf. Chamblis 2007). Thus for a school district to lose 1,000 students means a loss in revenue of $7.3 million direct to budget. The result is loss of teachers or other staff. Education constitutes 34% of the overall Florida state budget. The piece of good news is the easier ability to find teachers to meet the state mandated class size limits. Overall Florida needs to fill 17,000-20,000 teacher positions each year. In 2006-2007 Florida employed 168,181 teachers plus 29,097 instructional personnel (guidance counselors, librarians, etc.; cf. Rushimg 2007). If one had been watching carefully, the 2005-2006 school year actually showed the lowest growth since the1984-1985 school year (see Figure 5). School year 2005-2006 also showed the largest enrollment decline October to February in a decade (see Figure 6). Thus an issue is that overall school enrollment has stalled in Florida.

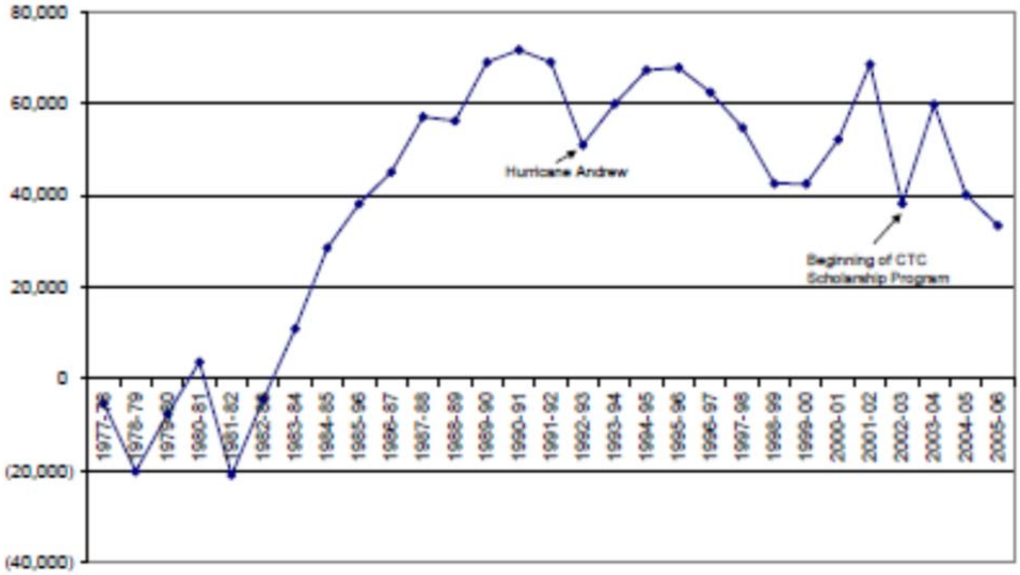


**Figure 5: Growth in Public School Fall Membership – Grades PK-12**

Source: DoE 2007

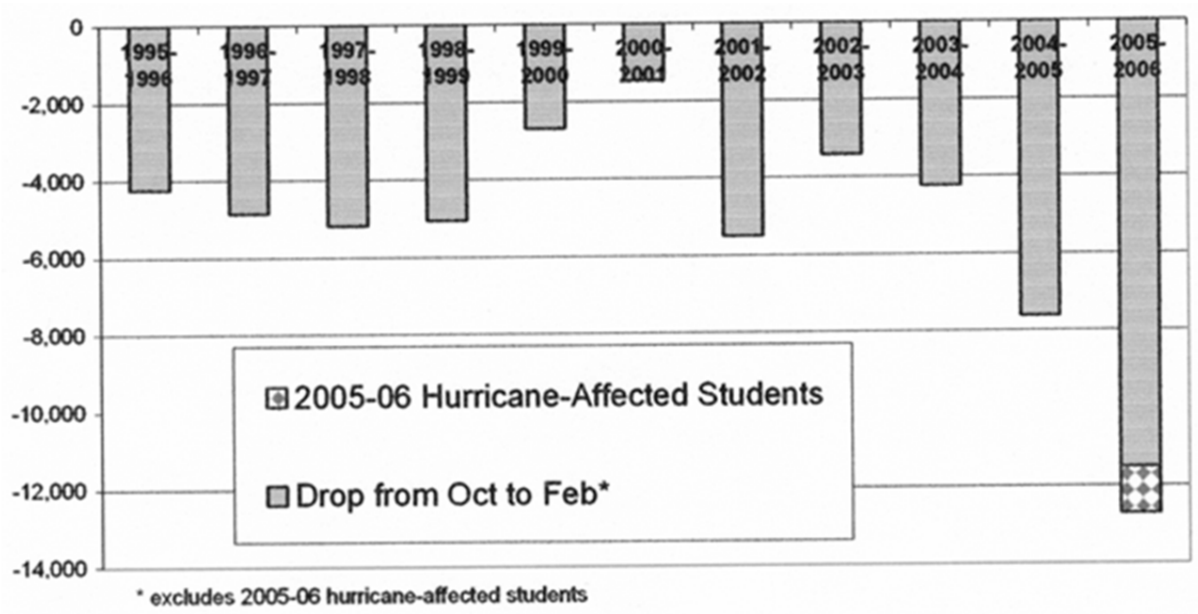


**Figure 6: K-12 Public Schools Numerical Decline in FTE Student Enrollment from October to February**

Source: DoE 2007

## 5 Moving Data

In early 2007 two national moving companies reported for the first time more outbound moves from Florida than into Florida. Atlas Van Lines reported the ratio out to in as 7,994 versus 6,716 (cf. DoE 2006). Texas for example showed a reverse ratio of 6,812 versus 9,714. For Florida net positive numbers for recent years were as follows: 2005 – 323, 2004 – 1,889, 2003 – 2,045, 2002 – 1,317 (cf. DoE 2006). Here again 2005 was small but not negative. In 2004 Allied Van Lines reported Florida as the state with the largest net relocation gain.[8] United Van Lines showed 16,212 inbound moves versus 17,019 outbound moves in 2006 (cf. Report 2005). For United Van Lines, in 2005 Florida had 54% inbound traffic but the lowest number of relocations to the state since 2000.[9] U-Haul, the do-it-yourself moving specialist, which does 1.6 million transactions per year nationally, found Florida to be unremarkable in 2006. Only one Florida city (Lakeland) made the 25 top growth cities, although four Florida cities were in the overall top 25 US destination cities (Orlando, Tampa, Jacksonville, Miami).[10] Thus moving data suggests a change in Florida growth patterns. There is a new outbound trend.

## 6 Traffic Data

In Palm Beach County, where student enrollment dropped 2000 in the fall of 2007, county engineers have also seen a dip in the number of cars on many roads. Traffic data released this year showed that nearly a quarter of the county roads used by at least 10000 cars per day have experienced a decrease in traffic from 2004 to 2007 (cf. U-haul 2007). Unfortunately such data is less generally available than school enrollments or moving data. While the Florida Department of Transportation has much data road by road across the state, little analysis has been published as it relates to population patterns.

## 7 Economy

The above discussion does not necessarily mean that the Florida economy is not strong or that the total population of the state is not growing. Tourism is up. Manufacturing is up (cf. Vittner 2007). Decline in population growth specifically relates to families with children and families with sufficient means and assets to use a major moving company. Such data does not consider foreign immigrants. South Florida (cf. Sorentrue 2007) growth is largely due to foreign immigrants, some 400,000 between April 2000 and July 2006. While domestic migration was negative since mid-2005. It is said that over 25% of Florida's population growth since 2000 is due to foreign immigrants.[11]

## 8 Conclusion

For decades Florida has had a pattern of extensive growth. It has been argued that that growth is based upon sunshine/beaches, low cost housing, low taxes, low living expenses, and ample jobs (low wage). Housing, taxes, insurance, living expenses are now higher than states such as Texas, Tennessee, and North Carolina. Salaries have not changed to reflect living expenses. The hurricanes have served as a reminder of dangers and of quality of life issues. Crime in some areas has become a problem. School enrollment and moving data suggest that growth (net of incoming and outgoing people) has stalled. Little (no) polling is done to determine the attitudes of people in other parts of the US toward moving to Florida. The scenario of no growth is not on the planners list of options. Will sunshine and beaches be a sufficient magnet for growth in the absence of low costs and with low wages in the future? How long will the present situation last? Or is there a new scenario which in fact will last for decades?

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8 Cf. 2006 Migration Patterns. Atlas World Group. – URL: http://atlasworldgroup.com/migration/.

9 Cf. 2006 Migration Study from United Van Lines. January 9, 2007. – URL: http://www.ndtahq.com/UnitedVanLines_Migration_2006.htm.

10 Cf. Southeast, West Continue to Attract Residents as Midwest, Northeast See More Leave. 2005 Migration Study. January 6, 2006. – URL: http://www.unitedvanlines.com.

11 Cf. Arthur 2007; Immigrant impact: Florida. – URL: http://www.fairus.org.

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# Methodological Experiences in Hungarian Foresight Activities

*Erzsébet Nováky, Éva Hideg*

## 1 Introductory Thoughts

We are living in unstable socio-economic processes, with significant social changes occurring and decisions being made with controversial effects on the population. This time, it is not sufficient to foresee trends, given that possible futures were developed by way of studying the facts of objective reality. Neither can we consider future expectations and planned actions by key stakeholders, because the affected population may act against future conceptions and decisions that can be regarded reasonable and professionally well-founded. Therefore, we should become familiar with the views, opinions and expectations of the individuals and the population regarding the future.

People tend to realize that they need to live with their future-shaping power for the sake of their individual future, embedded in the future of their wider environment. More and more people wish to be involved and do not regret the time and energy invested. Futurists should not make decisions or evaluate observed processes on their own. Stakeholders, attentive public and opinion leaders should be involved in the foresight process. This is the reason why we are working to improve foresight procedures which opens the way to a participatory approach (cf. Nováky 2004).

We have gained substantial methodological experience in foreseeing the future for education, regional development and in the macro sphere of society. The first social foresight study prepared in Hungary for the future of education was in (1992-1994 and 1995-1996) and the second one was carried out in 2006. We have elaborated public foresight procedures for regional foresight in two cases (Tuzsér 2000 and Kiskunfélegyháza 2003). We also used participatory future study methods to look for future alternatives for Hungary, beyond tomorrow. We are of the opinion that methodological experiences thus gained can also be used in the area of technology foresight.

## 2 Foresights in the Field of Vocational Education

In Hungary the first social foresight was prepared for the future of education and vocational training (between 1992-1994 and 1995-1996; cf. Hideg/Nováky 1998b). The foresight project was conducted and accomplished by authors of this paper. The first phase was part of a World Bank programme to develop education of Hungarian youth, while the second phase was ordered by the Hungarian National Institute of Vocational Training.

The aim of this foresight activity was to elaborate complex, long-term development alternatives for domestic vocational education. The most important stated goals were to

- underpin development of the Hungarian system of vocational education;
- explore expectations of stakeholders of vocational education regarding the future;
- establish the position of vocational education in social future-models;
- provide possible, desirable, complex and consistent futures alternatives to policy makers and other stakeholders;
- influence policy makers towards the most desirable and affordable direction of development.

During that time, the know-how of forecasting was generally known and popular, so we started our researches as if it were a social forecast activity. *During preparatory work, however, we soon realised that proceeding with the project could not be a forecasting-type activity*, because domestic trends were changing after Hungarian political transformation (in 1998) and international trends also showed signs of shifting in education and vocational training tendencies. Consequently, we had to develop a new methodology to solve the given futures task (cf. Hideg/Nováky 1999). Under these conditions we had to reveal whether Hungarian society showed signs of change, new thoughts, expectations and intentions that would imply modernization of the education system. We therefore interviewed socially decisive actors of education and vocational training, how they saw the problems, identified possible avenues of development of the Hungarian educational system. In addition, we wanted to offer an international outlook and to include its results to the stakeholders' expectations. Therefore our attention was focused on the following three areas:

- Placing the problem in an international context, we were mainly interested in how certain well-developed countries and region, known to be spearheading even faster development of the time, defined socio-economic functions of vocational education and corresponding tasks.
- What was the position of the decisive players in the Hungarian vocational education system on the problems and prospects for future development in this area?
- Were there any clear future alternatives which could be developed, based on the expectations of different stakeholders and which could be seen as local solutions of global and regional problems of vocational education?

Our study of international outlook was focused on products of futures studies, the aim of which was to describe social future-models and which concentrated on the long-term development strategy of education and vocational education. This work was done by experts of foresight in the form of study writing.

In the first phase of the project, stakeholders were given the task of studying 65 schools of vocational education which took part in the World Bank programme. School directors were asked about their ideas of development of Hungarian vocational education, by using a two-round Delphi method. It was noted that there was yet another involved and important stakeholder in vocational education, namely the Hungarian population, because people had attended, were attending or might attend school at any time. *Representatives of the Hungarian population were interviewed by using one-round Delphi, so-called public Delphi method. We were interested about their future orientation and the role of schooling in their life*.

The second phase of this foresight activity was carried out in terms of extending the circle of stakeholders and deepening vision of possible future alternatives for developing Hungarian vocational education. In the second phase, selected circles of stakeholders were:

- schools involved in vocational education as providers of school service;
- children participating in vocational education as students;
- parents directly associated with some form of vocational education, whose decision and expectation influence the schooling of youth;
- employers, as "consumers" of vocational education, who require qualified workers in their working process.

That foresight activity was extended to include the whole Hungarian society, therefore the involvement of stakeholders was carried out through their representatives. The method used was the one-round Delphi. Our hypotheses, that (1) each group of stakeholders was competent in a different scope of issues; (2) valuable information could be gained about the Hungarian society and economy (as the environment of vocational education), about social functions and possible systems of vocational education, if different questions were put to the different types of stakeholders; (3) stakeholder involvement was achieved in different ways, which in time proved to be correct, on the basis of historical valuation of future alternatives of vocational education, elaborated during that foresight activity which is still under discussion.

After surveying opinions and expectations of stakeholders, comparative and consistence analyses were carried out by foresight experts. The aim of consistence analysis was to fit the valuations of situation (given at the time) as problems and expectations regarding the future of that time as possible problem solutions for vocational education to one another, also with a view to results of international outlook.

*Futures workshop technique was applied in Hungary, firstly in foresight activity*. In the first phase a futures workshop was held with the participation of so-called "World Bank Schools". The results of stakeholders' workshop were feed-backed to the futurists' workshop for using additional future information in the development of future alternatives concerning Hungarian vocational education (cf. Hideg et al. 1995).

In the second phase, even more workshops were held, because more stakeholders were involved in the foresight procedure. The results of experts' and stakeholders' workshops were also fed-back to the futurists' workshop to finalize the two possible development alternatives regarding the education and vocational education system in Hungary (cf. Hideg/Nováky 1998b).

The second social foresight activity in the field of vocational education was organised for elaborating the idea of setting up a network of regional vocational examination centres in Hungary. It was carried out in

2006 on behalf of the National Vocational Training Institute[1] (cf. Bartus/Hideg 2007; Bartus et al 2007). The foresight project was led and accomplished by Éva Hideg.

The purpose of this foresight activity was to work out future ideas for a network of regional vocational examination centres, their possible establishment and forms of professional operation in terms of prevalent and future domestic conditions; including social acceptability and/or eligibility for support for the 2007-2013 period. The proposal for the establishment of the regional examination centres was based on research conducted on the following topics:

- The shared points of development paths of Hungarian and European Union societies and economies and the resulting considerations.
- Experiences of reforms with comparable objectives and subjects undertaken in other European Union Member States.
- The statistical and critical analyses of Hungarian vocational examination practice in the period 2000-2005.
- The ideas of stakeholders of vocational examination practice, such as examining teachers, examination board chairs, regional training centres, chambers of commerce, industry and agriculture, representative associations of employers, working to improve and develop the current examination system.

Research of the first three topics mentioned was carried out by experts through making analysis and development studies. Exploration of future conceptions of key stakeholders of vocational examination practice at that time was made by directed study writing. Some questions were put and while answering them, stakeholders could express their views and expectations about the present and future system of vocational examination. The stakeholders could answer freely because the questions provided only the framework for their answers. The content of answers was not influenced and the length of answers was also not limited.

We were unable to involve all important stakeholders, due to the limited time available for the research. The research did not extend to the opinions and ideas of examinees and persons ordering examinations. Our view is that they should be involved at the stage where professionally justified ideas have already been mapped out. One of the ways that this can be ensured – apart from publishing the results of the research – is to hold workshops for the various groups of examinees and future examinees, where the various vocational examination centre ideas and the models of their potential feasibility and operation would be presented and participants could try these models and express what they would accept and what they would want to change and why. In addition to these live workshops it would also be expedient to create an interactive online website for a limited period to ensure that the opinions and suggestions of the widest possible spectrum of citizens is taken into account during the transformation of the vocational examination system. Our position is that the involvement of those at the receiving end of vocational examination services could play an important role in the utilization of research results, e.g. during the process of detailed planning and / or a pilot programme.

We have gathered a total of seven different regional examination system concepts from the ideas presented by the stakeholders concerned. After gathering the opinions and expectations of stakeholders, a number of different filters were used to tone down the subjectivity of stakeholders. *These filters included comparative and consistence analyses, professional workshops with different compositions and number of participants.* After filtering we utilized these ideas during our synthesis work by aligning the ideas of the stakeholders to the views on the environment and the system of expectations gathered by studying the first three topics referred to above. That is why the final concept does not fully correspond to any of the ideas put forward by the stakeholders. Another reason for this is that within the various ideas of the stakeholders we strove to find

- common cores and elements,
- those shared points in terms of which the various ideas can complement, enrich one another, and
- possible sources of conflict, which must be resolved by finding possible modes of resolution in the course of our synthesis work.

The guiding principle of synthesis work was to define and interpret vocational examination in a manner that is professionally well-grounded and can aid the development of domestic practice and to draw up the

[1] Name of this institute has been changed. The National Institute of Vocational and Adult Education is the legal successor of the National Institute of Vocational Education from the beginning of the year 2007.

new institutional concept, the main functions of operation, the possible framework and feasibility of operation in line therewith.

*Workshops were the most definitive forms of synthesis work.* We have developed the concept of the new vocational examination centre network during these synthesis workshops. In addition, we have also identified the larger issues, where we have encountered diverging interpretations and have found an interpretative framework, which allows us to handle and answer questions in a manner that fits into a consistent system. One of the most significant tasks to be achieved during the workshops was to draw up alternative proposals for feasibility, estimation of material, labour and infrastructural requirements, as well as envisaged costs of implementation.

The concept and implementation ideas of the regional vocational examination network emerged through a series of workshops where participants were representatives of key stakeholders as experts of vocational examination, representatives of economic chambers, the representative of National Institute of Vocational Education and the leader of this foresight activity. Results of these series of workshop were sent to a larger group of experts and stakeholders as a working document, who then proceeded to work on the concept and possible modes and forms of implementation within the framework of a one-day discussion and workshop. *Participants of the wider scope one-day discussion and workshop were representatives of would-be stakeholders as trade unions, multinational and national enterprises, the Confederation of Hungarian Employers and Industrialists and representatives of the Labour Ministry as authority, besides representatives of key stakeholders mentioned.* The main reason of involvement of extra stakeholders was that the outcome of the series of workshops, according to which the circle of actors of vocational examination system should be expanded in the future so that vocational examination can better serve people's adaptation to labour needs and life-long learning.

We have also taken into account critical observations and proposals for further development, made at the wider scope one-day discussion and workshop. The synthesis study, the result of this foresight procedure, was primarily based on the experts' studies, discussed, filtered and fed-back future ideas of stakeholders, the outcomes of synthesis workshops and the wider scope one-day discussion and workshop in this way. *A "consensus future" has not emerged because of conflicting interests among different stakeholders (especially between the economic chambers and other stakeholders) but three future alternatives have taken shape.*

# 3 Public Foresight for Regional Foresights

## 3.1 The Future of Tuzsér Village and the Small Region of Felső-Szabolcs

The research was carried out in 2000, using public Delphi (cf. Nováky 2000). Participants were from Tuzsér (a small village in North-East Hungary, in a not so rich region) and people who are somehow related and feel responsible for the future of this region. The first round of the surveys mapped topics of the future that the participants thought responsibly about, and changes they thought would define the future of the region. The second round investigated what the possibilities were for development, and their expected time-horizon. The time-horizons were 1998-2002, 2003-2010, 2011-2025, 2026-2050, after 2050 and never. The intervals are widening with a view to neutralize growing instability. The third round, based on the results of the second round, examined events that were anticipated in each time-horizon and what the expected order of the events could be.

In the first round participants mentioned changes, referring to actual trends (e.g. education in the elementary school has a focus on environment protection) and weak signals (e.g. Tuzsér becomes a conference centre). The appearance, evolving and strengthening in the future of the top-down (e.g. development of vehicle traffic) and the bottom-up (e.g. cooperation of local communities) processes could be observed from the answers. The changes can be grouped according to their most important effect, such as economic, social, technological or environmental relevance. According to the answers, most of the events would possibly happen in the between the years 2003-2010. Two subjects regarded as "never to happen" and "the present situation would never change"; these were the kind of events participants were very much concerned about and thus they would not change without external initiation. These two critical questions were: ethnical conflicts and the development of the local bus transport; participants could not imagine that a turning point could come, so professionals' mediation is required.

Societal changes were considered to happen later than the economic ones: this is an acceptable and normal phenomenon, considering different time requirements of these processes. In environmental and technological topics people were very open to the changes, and they were willing to act for them, even though in some cases of external determination they were sceptical. About changes that were visible, appreciable and known they thought to happen relatively early and they seemed ready to act for them. Consequently, they were willing to take action for changes they can see the outcome of, but for processes of long-term result or long-term effect they were not so committed. Hence decision-makers, professionals and futurists have indispensable responsibility for the future, splitting the long-term projects into smaller cases and objectives, making them more familiar and accessible.

Events of unstable outcome in the questionnaire (e.g. nearly similar possibilities in two different and far time-periods) offered the alternatives for the future. Three alternatives could be created, regarding the focus of development: economic, societal and economic-societal. In the first alternative *the economic development* is in the spotlight, that later will cause the societal recovery. This carries the risk of inefficiency and increases the possibility of unwelcome developments in the small region. If the *development of societal processes* is significant, it will be based on modernisation, like expanding the Internet for education or communication purposes. In this case the unstable factor that threatens accomplishment is an ethnical conflict, which should be resolved. In the third alternative *societal and economic processes are strengthening each other*, but only in case that the system has a positive feedback, creating new possibilities and these changes have positive effects. The future orientation and responsibility of decision makers and the stakeholders is required to this end (cf. Nováky 2007). People are open to implement changes they are motivated for. To advance long-term changes, people have to be conscious about their possibilities, and also be aware that long-term future will come eventually, and we have to prepare for it in the present.

## 3.2 The Future of the Hungarian Town Kiskunfélegyháza

Kiskunfélegyháza is a small town in Southern Hungary. Its future was studied, based on its population's expectations until the year 2020, with the aspect of substantiating the development plans of the town. The research (cf. Nováky 2003) concluded that dealing with the future has become more important, the future belonged to everyone, so everyone should be involved in designing the future. Inhabitants' opinion was collected with a three-round public Delphi method. The three aspects of the questions were the following: (1) external processes that influence the town's societal-economic development, (2) forces inherent in the local management and the civil communities' and (3) townspeople's expectations of the future. The examined intervals were: until 2005, between the years 2005-2010 and 2010-2020, and after 2020 and never.

The results of the first round show that inhabitants were not particularly innovative, they were interested about the future just to break away from the present. Despite this, their thoughts about the world were complex and coherent. People were the most undecided about the factors on world economics, on the EU and on the labour force. The majority thought that most of the events and changes would happen between 2005 and 2020. They thought that local management is not sufficiently innovative or creative. They agreed that the role of civil movements / communities was important, but the relationship with the local governance is not successful yet, thus it should be developed. At the end of the third round it became clear that they were very uncertain in a lot of questions. One of the uncertainties was linked to Hungary's joining of the European Union. The research took place before our EU membership, so people could not know what to expect from it, what effects it would have. Some favourable events, like the increasing protection of the environment, job creation or canalisation, were considered to happen in the distant future. This vast instability means that they did not trust the positive influence of certain processes, and this ultimately leads to inactivity.

With some answers the participants foresighted the situation of not only Kiskunfélegyháza, but of the whole country, like how development projects fell through, despite given possibilities. We now know that in present-day Hungary we are not able to benefit from various opportunities, economic growth is slow, funds from the EU-tenders are not allocated well. Many answers alluded to this, even though we were two years from joining the EU and that time the only factor that could turn the climate of opinion optimistic about Hungary's EU membership were the high expectations about possible EU support.

Alternative scenarios were designed for the future of Kiskunfélegyháza, based on the evaluation of instability and possibilities: like expectations about reliance or fear and whether possibilities are appreciated or depreciated. The four alternatives are: "Successful Future", "Pusillanimity", "Confidence" and "Unhappy Future".

The *"Successful Future"* turns true, if the development does not run into any material or personal obstacles; a preferable scenario. Expectations filled with fear, hinder the development in the case of *"Pusillanimity"*, but it can be avoided with a strong guidance that overcomes fear and strengthens favourable processes. Its advantage is its risk as well: a pusillanimous community can be easily led and used. If *"Confidence"* rules a community the way out from depreciated possibilities is conscious future orientation, which can open up new possibilities to for development. In an *"Unhappy Future"* attitude, local development options can fail due to inadequate guidance, illusory expectations about EU or other funds, moreover there is no constructive relationship between the town governance and the population to resolve this situation.

These alternatives are simplified visions of the future, a mixture of these could probably come true. A common feature is that the decision makers have two tasks: examination of the stability of processes, to see clearly which ones could be changed and which ones are the most sensitive; to shape and making real and conscious the future-designing forces, expand the studies of future orientation and improve the future-consciousness on this basis. Without these activities the expected development will not be successful or it will take more time (cf. Nováky 2006). But communities and the future cannot wait, we have to take actions in the present!

## 4 Looking for Future Alternatives for Hungary beyond Tomorrow, by Using Participatory Futures Studies Methods

This is the third long-term complex future image for Hungary, completed in the year 2000. The first one was constructed in the early 1970s, focused on the NNP per capita with top-down approach. The second complex future image, of the mid-1980s, concentrated on individual necessities. The third future image of Hungary is the study *"Hungary beyond tomorrow"* (cf. Nováky 2001), its aim is to find acceptable alternatives for the future, instead of finding and shaping the most probable future. In the study more methods are used and the results are presented with scenario building, because some facts were evident: the emerging and differentiating future orientation of individuals, societal institutions and enterprises; the observation of many seeds of change in the present; and generally the feeling of the unstable circumstances. The approach is dynamic and complex, offering the possibility to top-down and bottom-up observations.

We know from previous examinations of future orientation (cf. Hideg/Nováky 1998a; Nováky et al. 1994) that in the 1990s people's future orientation had practical reasons: the main goal of the activities was to assure the right future for the family and the children, plus to organize the work rationally. Participants did not perceive that hard work and other activities was the source of qualitative changes, because they thought it was difficult to cope with the circumstances. The future of enterprise orientation is filled with fear, and enterprises are thinking and doing very little about the future. Consequently, the economic situation and its factors were analysed in "Hungary beyond tomorrow".

Different future alternatives were formulated, according to the possibilities of political and economic (Hungary and the global world) development. These scenarios or versions of the future are not based on trends, but on future possibilities, built upon alternativity and instability-based bifurcations. Eight versions of the future were developed: all of them were possible, but not all were acceptable for society. The eight versions were examined from three other aspects to highlight the question of acceptance and support: expectations of joining the EU, changes in values and individual aspirations. Hungary's EU membership divided the population, therefore people's relation to the eight versions was not homogenous: hope, pragmatism, ability and disability were the four groups that could be identified. From changes in values another four groups were created, based on the idea that similar values were important for somebody: new consumer values with varying life-styles; environment-friendly values; peace, security of the family, happiness and material welfare; trustworthy, responsible, brave, rational and helpful values. People with different values could accept and support different versions of the future (cf. Masini 1993). Individual aspirations as the third aspect could be the future of the family and of the children; influencing the future; "space-age" perspective; education and work in the future. The eight versions of the future were filtered through these three aspect groups, and it emerged that two of the versions (the 2nd and 7th) were acceptable from some aspects, while everyone was ready to accept one of the eight versions (the 1st). This latter one is a future, based on regional integration, on economic policy with prominent national interests and a balanced development within the European Union. To reduce the high number of versions, another two aspects were introduced: possibilities, thence stability or instability of the processes and the environment, and expectations that favour changes or not.

In the first alternative, possibilities and expectations are in balance, they are both stable, so it causes idleness and postponing actions and changes. In Hungarian we call this the *"Pató Pál-effect"*, which is similar to the Spanish *"Maňana"*: i.e. leave everything for tomorrow. The second alternative contains *"the societal claim for change"* that typically generates revolution, without unstable processes, like it happened in Hungary in1848 and in 1956. The third alternative offers the possibility of change, but with the lack of interest surrounding it (due to unfulfilled possibilities and fear of change) – after a while this future can be termed *"the ship has sailed off"*. In the fourth alternative, Hungary is ready to make favourable changes and societal expectations – *"the winner takes it all"*!

The 2nd and 7th version, that were termed as "partly acceptable" for everyone, were collateral with the fourth alternative (possibility of big changes), while the 1st version, that everyone could accept, was part of the second alternative (where processes and the environment need to be changed). As a consequence we can state that the ability of innovation and the presence of future designing forces are definitely necessary for reaching a breakthrough.

Today we are aware that expectations connected to EU membership were too high, and activity was lacking to make changes happen. The study on "Hungary beyond tomorrow" projected this drawback. The only way to change the future is to think about it, then take action for it. The activities can be followed by expectations, but expectations without action will not change anything.

## 5 Methodological Experiences for Technology Foresight

We are of the view that our methodological experience gained while leading social foresight activity can also be applicable in the field of technology foresight. Technology foresight consists not only of a list of new possible scientific solutions, embedded in technology novelty, but also of new socio-economic relations to technology and its development and human acceptance of possible new technology. The latter two relations are of particular importance if technology foresight is carried out. Human relations to technology foresight could be strengthened by taking into consideration of our methodological experiences.

1. In social foresight projects discussed, working with participatory tools developed in critical futures studies were preferred to involve stakeholders, including non-professionals as well, and to integrate their future expectations into the future shaping process. The main aim of methodological solutions thus developed was to produce synergy between future thoughts and expectations of professional and non-professional stakeholders.
2. Stakeholders have different ideas and expectations depending on their future orientation and position in the system, their future is the object of foresight. Their ideas and expectations constitute building blocks in foresight activity and vice versa the ideas and expectation of stakeholders developed by participation in foresight activity.
3. Given that stakeholders are competent in different scopes of issues, therefore their involvement in the foresight procedure should be achieved in different ways depending on the aim, task and object of foresight activity.
4. Important are not only the typical future thoughts of stakeholders, but also the extreme ones, if they can become the object of discussion and generate new future alternatives during the process. Therefore, maintaining the right and possibility of freedom of speech and free expression of opinion, is the focal point of the whole foresight procedure.
5. Both direct and indirect subjective methods should be used for exploring, generating and applying future thoughts of stakeholders.
6. Comparative analysis of futures ideas and expectations opens the way to look for consistency and inconsistency among stakeholders' opinions. Dialogue among stakeholders can serve both consensus building and mapping of future alternatives.
7. Futures workshops help to highlight potential conflicts among stakeholders that can ultimately lead forward to another trajectory, which is different from the present one.
8. Neither scientific experts nor futurists are able to find out or invent the future, but they can contribute to outlining the framework of possible futures.
9. Dialogue between scientific experts and different stakeholders, also helps to bridge distances between scientific and practical knowledge about the future.

10. Dialogue has proved to be a useful means to generate reflexive learning and knowledge production regarding the future.
11. Methodology and methods used are also dependent on the aim and object of foresight. There is not one good foresight procedure and combination of methods for all purposes.
12. Search for further opportunities of stakeholder participation in foresight activity, should be an important research topic for futurists.
13. Laymen are mature enough to articulate their opinions and their future expectations, while futurists, using the tools of academic futures studies, can open the process and involve them in helping to develop future alternatives and foresight specialists.

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# Some Remarks on Future Thinking

*Gerhard Banse*

## 1 Introduction: A Short Review

If we look at the contributions of the Sustainable Technological Development Forum, December 2005, we can find interesting remarks in two directions: to visions or utopias and to foresight (cf. Banse et al. 2007).

1. Presentations on Visions and Utopias related to Nano- and Converging Technologies:
   – Christopher Coenen: Utopian Aspects of the Debate on Converging Technologies (pp. 141-172);
   – Hans-Joachim Petsche: Will We Find Utopia? Converging Technologies and Human Beings (pp. 173-180);
   – Zoltan Galántai: Nanoutopias (pp. 181-189).

2. Remarks to Foresight:

Explicit in the contribution of René von Schomberg "From the Ethics of Technology to the Ethics of Knowledge Assessment", in chapter 4 "Foresight and Knowledge Assessment" (pp. 313-315) and in chapter 5 "Foresight and Deliberation" (pp. 315-319). As a summary of Schomberg's reflections we can understand the following:

1. "Foresight knowledge is non-verifiable in nature since it does not give a representation of an empirical reality. It can, therefore, also not be related to the normal use for the 'predictability' of events. The quality of foresight knowledge is discussed in *terms of its plausibility* rather than in terms of the accuracy of the predictability of certain events. Foresight exercises are therefore often characterised as 'explorative' in nature and not meant to produce predictions.
2. Foresight knowledge has a *high degree of uncertainty* and complexity whereby uncertainties exist concerning particular causal relationships and their relevance for the issue of concern.
3. Foresight knowledge thematises usually a *coherent vision* whereby relevant knowledge includes an *anticipation of 'the unknown'*.
4. Foresight knowledge has an *action-oriented perspective* (identification of threats/challenges/opportunetics and the relevance of knowledge for a particular issue) whereby normal scientific knowledge lacks such an orientation.
5. Foresight knowledge shares a typical *hermeneutic dimension* of the social sciences and the humanities, whereby the available knowledge is subject to continuous interpretation (e. g. visions of 'the future' or what can account for a 'future' are typical examples of such an hermeneutic dimension).
6. Foresight knowledge is more than future-oriented research: it combines *normative targets* with *socio-economic feasibility* and *scientific plausibility*.
7. Foresight knowledge is by definition *multi-disciplinary* in nature and very often combines the insights of social and natural sciences" (Schomberg 2007, p. 314).

But utopian and foresight thinking are different forms of future thinking.

## 2 The Problem

Since people reflect their being, they reflect their future – they think future (cf. also Banse 2004, 2008). And this more with a practical than with a theoretical intention (more "utilitas" than "curiositas") – future thinking is based more on the expected benefits than only on the curiosity!

At first, the near future was the subject of future-thinking: harvest and crop, successful hunting, travels a. s. o., later, the far future.

For future-oriented thinking in history there are at present various types:

- myth;
- prophecy;
- oracle;
- utopia;

- vision;
- forecast/prediction;
- scenario.

If we look in the present we can see, that the practical intension continues (eq. for planning processes).

But changes are in the knowledge basis for future thinking (for example, in comparison with the “Old Greek”): Future-oriented thinking in principal was access to:

- an enormous store of knowledge (given above all by the sciences);
- a broad methodical basis (eq. by the possibilities of mathematics and mathematical modelling);
- a developed technological basis (eq. computing).

But: Are there with these better cognitive and methodical conditions better possibilities to “think of the future” and act in an adequate way?

And: The following sentence of Mark Twain is as valid as ever: “Forecasting is very difficult, especially about the future!” (An example: In 1981 Bill Gates said about personal computers “640K should be enough for everyone”.)

So the answer to the above question isn‘t a simple “yes” or a simple “no” – it depends on the concrete situation, the field, the analysed space of time a.s.o.

And: There are some interesting theoretical problems, eq.

- relationships between more stable and more instable (“sensitive”) phases;
- relationships between continual and erratic changes;
- relationships between effects in short-, middle- and long-time;
- relationships between more linear-deterministic and more stochastic processes.

## 3 Limits of Future Thinking

The future is open! That means we have no way to produce valid knowledge about the future. There are no methods – but also not the most clever – for having such knowledge.

But this isn’t an argument against future thinking:

1. Future thinking is a “conditio humana”.
2. This argumentation shows the limits of future thinking: We must consider always, that there may be (or is!) a difference between the future in thought and the future in reality (which is then the present or the past!).

If we consider this, then future thinking is a kind of handling the “unknown”, to reduce this “unknown”, to build a bridge between the (known) present and the (unknown) future.

To stay in this picture then this bridge has two foundations:

1. knowledge;
2. belief.

Knowledge and belief have different forms:

- knowledge: descriptive statements, norms, instructions, prescriptions, …;
- belief: hopes, dreams, desires, expectations, convictions, cultural background as tacit knowledge, …

“Belief” in this sense means not a – or only – the religious form but a persuasion in a broad sense, as a basis of actions. As an example: Columbus had faith in two facts – the earth is a globe and if he goes to the West, he’ll come to India. This was as a persuasion the basis of his travel! And: There is the belief in the unlimited possibilities of science (and technology) in some parts of the world!

There are above all the proportions between these two “fundaments” which have changed in history. This “bridge” between the present and the future has different “constructions”:

1. One main-type of this “construction” are the *extrapolations*: Present states or processes will prolong beyond the “today” – mostly in a linear manner. Legitimation for that often experiences from the past. The basis are stable or as stable accepted developments. Results are trends, statements of tendencies a.

o. Examples are statements to demographic changes or to the demand for workers (eq. teachers in the schools of Berlin in the next year). Extrapolations are possible mostly without problems for processes under conditions of “classical mechanic” (“prediction” of a lunar eclipse or the eclipse of the sun) – but often only under idealised conditions. This is in the tradition of René Descartes’ “counting/calculating – measurement – weighing”. But mostly follows that was interesting is in future not the “rules” of classical mechanics – is not so easy or not at all calculable.

2. The second main-type is the so called *retropolation*: There is a derivation from an accepted state in the future (eq. a vision) for making in the present to reach or to avoid this state. An example: In the year X the emission of $CO_2$ must have the value Y. Then it is necessary to have every year a reduction by Z%.

In both types the future is a (in specific way) prolonged present. Concepts of the future are projections of the present. The starting point is the reached state with its positive or negative evaluated components.

One form of future thinking is the scenario method. It shows some interesting points for future thinking in general.

## 4 The Scenario Method

The scenario method was developed in the fiftieth and sixtieth by Herrmann Kahn and his colleagues – as a prognosis method, especially for non-linear and non-calculable events (cf. Kahn/Wiener 1967). But: The most in the future which is interesting for us isn’t non-linear and non-calculable!)

The main characteristic of the scenario method is the so called “scenario cone” or scenario funnel” (see Figure 7): With the beginning of the present (actual status) the frame of thinkable developments is marked. Through the more und more distance to the present the field of possibilities for “futures” becomes bigger. In this cone or funnel later we can find the single scenarios.

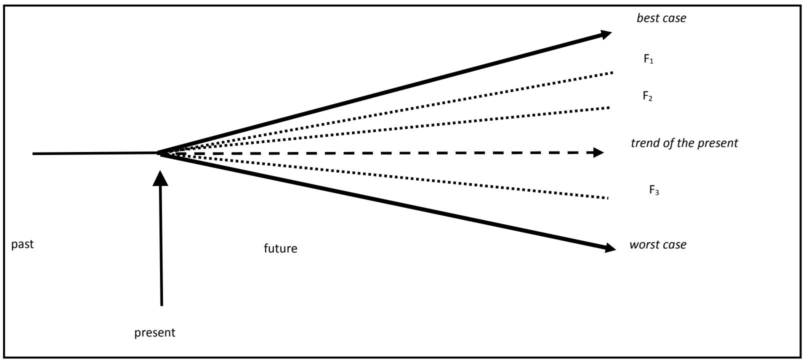


**Figure 7: The Scenario Method**
Author’s archive

The main tasks of scenario method are:

- to sign the trend of the present developments;
- to constitute the threshold values for possible development as limits of the cone ore funnel.

The aim is to establish a catalogue of activities or measures to attain or avoid this scenario. Advantages or benefits and disadvantages of the scenario method are (cf. Sträter 1988):

- it is possible to show complicated fact and development;
- it is possible thereby to identify important factors and relationships;
- it is possible to show political options (an so about these options a discussion is possible);
- it is possible to include qualitative (“smart) and quantitative (“hard”) data.

But: It is not value-free. Because there is a selection of options or ways for development, a potential for abuse is given (to “forgot” specified conditions; oversized influence of subjective expert meanings, which haven’t the possibility for a verification; political considerations aren’t to be avoided).

So we can see that there is (exists) a set, a spectrum of values for the evaluation and selection of the different scenarios.

## 5 The Influence of Values

The spectrum of values is related to the evaluation of “possible futures”. Like the positive and negative conceptions in utopian thinking in the scenario method always are “best case”- and “worst case”-scenarios:

- utopias as “the best of all thinkable worlds” – best case scenarios;
- dystopias as “the most bad of all thinkable worlds” – worst case scenarios.

The field between the best and the worst case scenario often is characterised as a “field of tension”. Examples are data protection in the “field of tension of freedom and security/safety” or privacy in the “field of informational self-determining and state-controlled interventions”.

These examples show: Thinkable worlds or scenarios are not per se good or bad but only in relationship to an external set of values. This set of values decides over the evaluation of thinkable scenarios as a “good” or a “bad” scenario. And: This set of values is different from individual to individual, from time to time, from culture to culture, from society to society.

In this relationship one of the main questions is the following: Are there possibilities for a “trans individual” evaluation? Are there more general values and preferences? Cautiously we can say “yes”!

Possibilities are:

- criteria for the compatibility in a human or social direction;
- criteria of sustainable development (cf. Kopfmüller et al. 2000, pp. 129ff.);
- so called “human criteria”;
- criteria for technology assessment; eq. the “octogon of values” by the VDI guideline from 1991 “Technology Assessment”: functionality, economy (microeconomic), prosperity (macroeconomic), safety, health, environmental quality, personality development and societal quality (cf. VDI 1991 – see Figure 8).

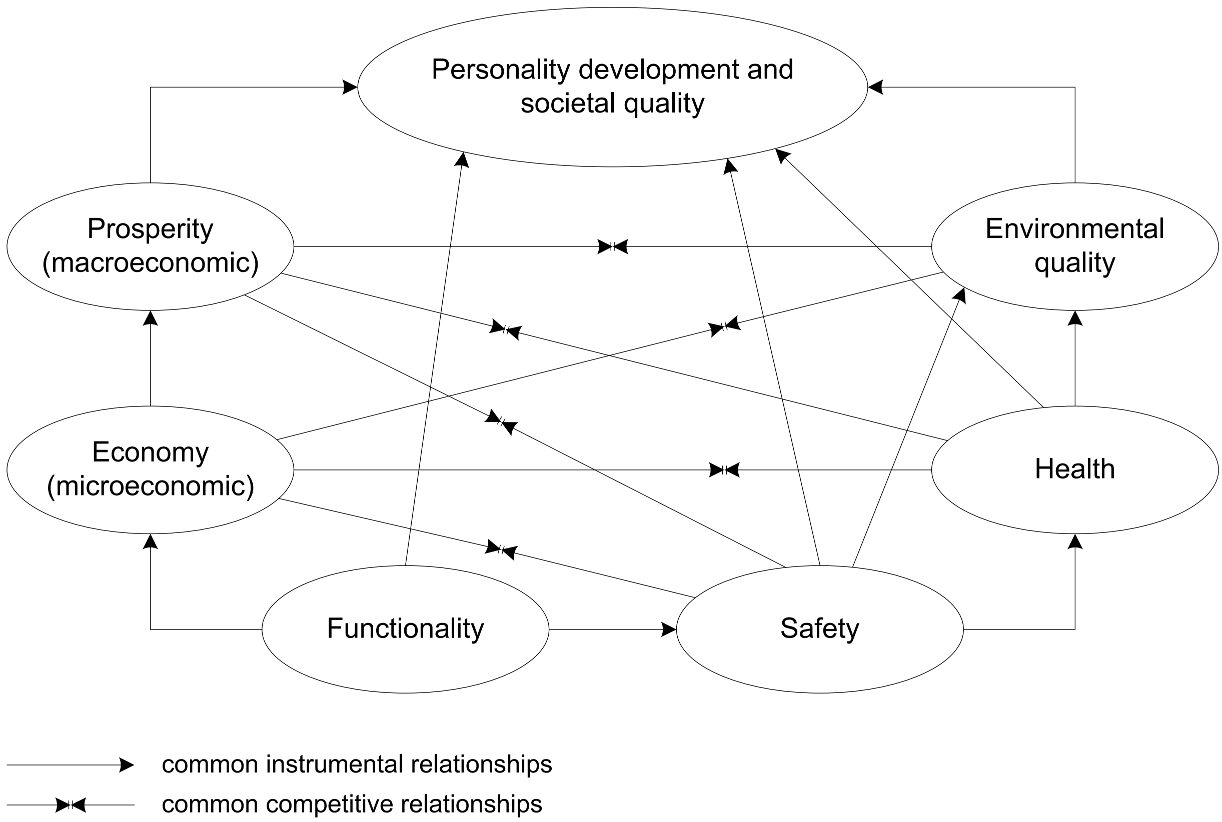


**Figure 8: “Octogon of Values” for Technology Assessment**

Source: changed after VDI 1991

Figure 9 shows the influence of values and evaluation in the process of engineering design and the using of technological systems.

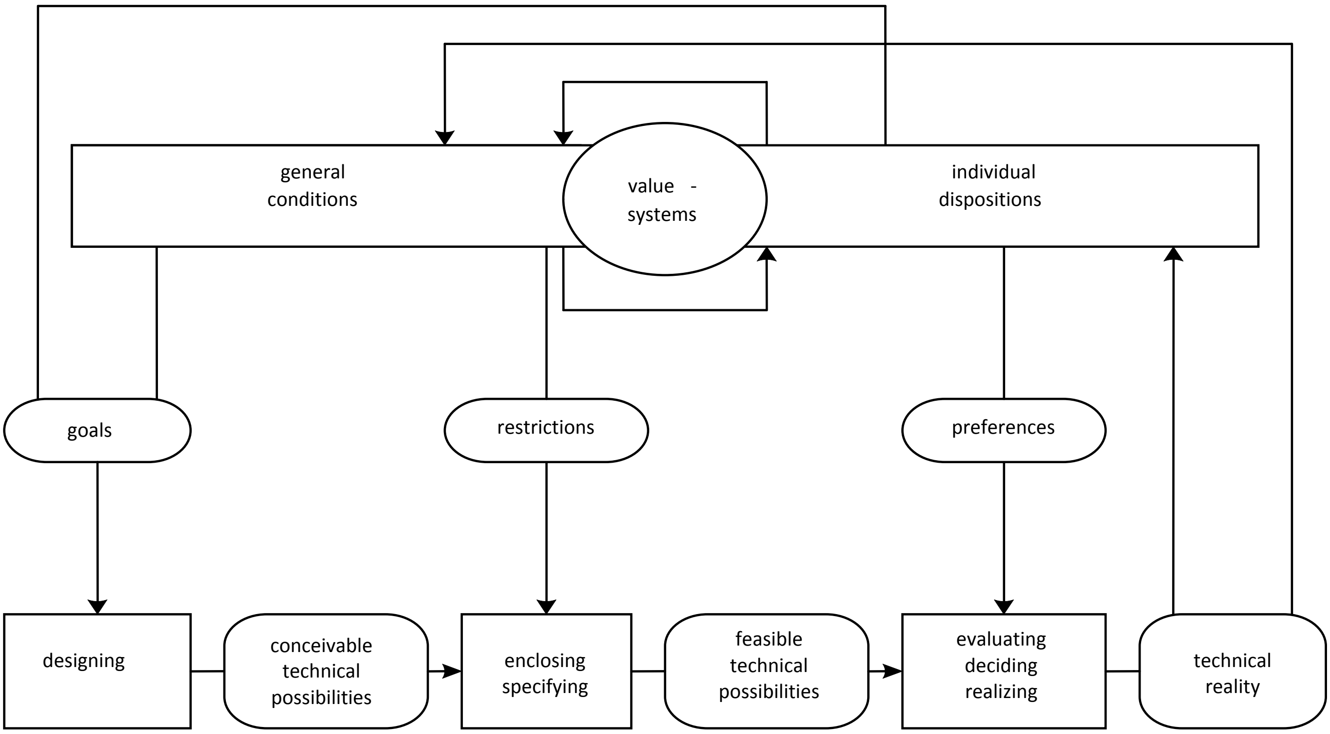


**Figure 9: Development and Selection of Technological Possibilities**
Source: VDI 1991

Important fields in all these possibilities:

- the relationships among the different values (instrumental r.; r. of competition or opposition);
- problems of the operationalisation of these criteria.

# 6 Conclusions

1. The un-known about the future isn‘t eliminated in principal. – In this direction our life is a life under uncertainty.
2. But because our life is a mostly planned life we need future thinking.
3. Future thinking is always a projection of the present.
4. “Pictures of the future” are value related – oriented at aims which are aspired (or not aspired).
5. Future thinking based on knowledge and beliefs must consider the differences between theory and practice and between plan and result.

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# The Methods of Hermann Kahn. The 2000 Forecast revisited

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## 1 Introduction

The practical value of successful predictions is one of the basics for the success of scientific methods. Mostly we are acting according to knowledge that has been won by assessments, forecasts, calculations and extrapolations of the already well known. Hence, a good theory may explain all relevant phenomena within the restricted realm of its validity. This is the comparably simple case of retrodiction.[1] A second task of the theory is future oriented: it should allow producing reliable prognosis about new and unexpected phenomena.[2] In the first case the Newtonian mechanics allows us to act according to everyday physics like driving cars or bicycles, moving heavy weights and other things. A surprising prognosis about the behavior of matter moving nearby with the velocity of light, was given by the Special Relativity Theory by Albert Einstein (cf. Einstein 1905) which can be understood as a generalization of Newtonian Mechanics. It allowed forecasting surprising results like the compression of time and space, dependent on the state of motion of the observer. Most theories in Physics, Chemistry and Biology are interrelated by the so called correspondence principle: an old theory is embedded in a new one as a special case. Hence, the equations of Newtonian mechanics can be deduced from Special Relativity Theory taking the velocity of light $c \rightarrow \infty$. From the point of view of everyday physics this is a good and practical approach.

Hypothesizing a reality, independent of human consciousness, cultural circumstances and conceptual contexts, a theory, capable to deduce future events like an experimental result, is then considered to be more adequate with the presumed underlying processes than other ones. This is, more or less, a rough picture of the role of prognosis within the positive, i.e., empirically based sciences. A useful prediction supports the theory in which it is grounded.

The problem starts when we have no adequate theories about the objects of concern. There is no really strong theory comparable with the level of theories in physics, chemistry, biology and other natural sciences in the field of history, sociology and – much more complicated – in the field of technology development. Due to the complexity of the interacting factors ruling the development of technologies, there is no theory (in a strong meaning of this term) which could allow making serious predictions. In this field of research we cannot prepare the boundary conditions like in a physical experiment. Moreover, there are no concise hypotheses how to explain the already known developments in the history of technology. Historical processes are no physical processes. It is true that the history of development of technologies sometimes seems to have abrupt phases. On the other hand, if one increases the timely resolution of the observation intervals in a post hoc analysis, the development becomes more and more continuous.

It seems to be the case, that there is an analogous correspondence principle in the development of technologies, like in the development of theories about nature: frequently, the progress in technology is driven by substitution of a partial technology, that is embedded in the old technology, by a new one: a new technology corresponds with an older technology, if there is a common core of both such that for a given technology parameter a new technology can be represented functionally or substituted by the older one (cf. Kornwachs 2002, 2007a, p. 73).

Unfortunately, the prognostic power of theories in Natural Sciences cannot serve as a model for theories about the development of their theories. More general: despite the fact, that we cannot develop technologies that would contradict well known physics, the development of technology cannot be either explained

1 This coincides with the deductive-nomological explanation in science. As an example: All metals are conductors, this piece is made by metal, and therefore this piece can conduct electrical currents; cf. Popper 1956.

2 More general: A theory $T_1$ that may predict more new or future events than another $T_2$ which can only explain already known phenomena is considered to be more adequate. Nevertheless one has to consider contingent historical circumstances to judge what a new event may be; cf. Menke 2009.

or anticipated by the already known physics. There is no system of all possible inventions,[3] even if we would have a theory about everything.[4]

Hence there is no theory about development of technology that is even able to make good retrodictions; one is forced to apply more intuitive views about the possible developments in the realm of possible futures. There are three ways to do this: First is prophecy with the help of supranatural forces like the Delphi Oracle or the prophets in the Jewish Torah. Second is to make extrapolations of well known developments with increasing uncertainty in the future and the third possibility is given by the scenario technique. Nevertheless, the last method remains an art with considerable shares of intuitive assessments.

# 2 Contemplating Future Technologies

To keep the paper short, the term *technological development* is defined apodictically as follows (cf. Kornwachs 1994): It encompasses the past and future changes of

- the artifacts (instruments, devices);
- the technical functions thereof;
- the organizational closure (all the technical and organizational co-systems necessary to unfold the technical function of a device);
- the ways of production, use, and waste management;
- the impacts on environment, economy, society, and politics.

This corresponds to an enlarged concept of technology which has been introduced during the discussion about Technology Assessment and Evaluation of Technology by the German Association of German Engineers in the 1990s (cf. 1991).

## 2.1 The Determinants of Innovation Processes

The so called innovation process is seen as an incubator of new technologies. This presupposes a model about what is going on when an invention or discovery gives rise to a product development. Usually, there are some steps which can be repeated by means of feedback slopes: Invention, explanation in the realm of the already known, a guess of application and technological function, i.e., a product vision, looking for a financial and institutional framework to develop a useful product, release and market diffusion.5 In all steps we have factors that may interact with each other in a very opaque way. As a rule, an invention as well as a discovery is a surprising event. It cannot be forecasted per definitionem, but it is possible to facilitate the probability of inventions and discoveries by managing good conditions for scientists and engineers like time, money, and excellence. A decisive factor is the investment into Research and Development, and this factor is determined again by the expectations and innovation policies of companies and firms.

The policy of the German Academy of Technology Sciences may serve as an example. One tries to support innovation processes hoping that successful innovations in products, services and procedures will sustain economic growth, welfare and working places. To achieve this, one has to investigate on the one hand the fields in which the support of innovation processes could be promising. This is the task of counseling the government and economy. On the other hand one has to look at the dynamics of the innovation process itself. Both issues require certain models about the generation of new technologies.

## 2.2 Visions

To have visions about technology means to take a look at technological functions that could be needed in the future. This leads to a more or less utopian list of wishes and goals. Here is the field of wishful thinking, projections, hopes as well as fears. Thus, we know that a technology for final nuclear waste management must be developed, but we don't know any solution. Or we may have the vision that cars are running automatically on the streets, controlled by our oral commands, without car crashes and traffic jams. Such kinds of visions have nothing to do with forecast. Nevertheless, they can influence, if publicly discussed,

[3] As hypothesized fictionally in the drama “The Physicists” (1962) by Friedrich Dürrenmatt (cf. Dürrenmatt 1991).
[4] Former called “Unified Field Theory in Physics”.
[5] For innovation processes see generally Kornwachs 2007b; Spur 2006.

the inclination of decision makers in technology policy as well as in company's Research and Development departments.

Today, we know already old projections of future technologies. The medieval philosopher and theologian Roger Bacon (1214 – 1292) taught that art, although nature is powerful and marvelous, when "using nature for an instrument is more powerful than natural virtue"[6] And he continues in his „Epistle […] on the Secret Works of Art and of Nature and also on the Nullity of Magic":

> *"There may be made instruments of navigation without men to row in them, as huge ships to brook the sea only with one man to steer them, which shall sail far more swiftly than if they were full of men. […] and chariots that shall move with an unspeakable force, without any living creatures to stir them, […] yea instruments by which to fly, so that one sitting in the middle of the instrument, and turning about [a device] by which the wings being artificially composed may beat the air after the manner of a flying bird. […] Moreover instruments may be made wherewith men may walk in the bottom of the sea or river without bodily danger".*[7]

## 2.3 Extrapolations

We extrapolate time series of quantitatively measureable values from which we believe either that they will influence the development or that they will provide an indicator. To the first we usually count technological indicators themselves, like gain, efficacy, performance, quality, audits fulfilled, reliability, density of damages, separable functions etc. To the latter we count economic indicators like the development of specific stocks, dynamics of sales for key products and services, installed devices, life time of products, innovation cycles, development of taxes for products and services, GNPs, prices, budgets for Research and Development in companies as well as public budgets for precompetitive research, number of patents and applications thereof (cf. Grupp 1997; Grupp et. al. 1987; Kornwachs 1994). Further indicators are related to social issues like changes in qualification needs and quality of vocational training, hire-and-fire dynamics in high-tech companies, changes in safety rules and laws, numbers of appeals against certain technologies and their use, acceptance and critique of technologies in surveys. These extrapolations give rise to the so called surprise-free approaches.

In principle, Technology Assessment is forced to go this way, since the possible and future effects and impacts of an already existing technology, or of a technology to be developed by decision, or of a future technology, can only be anticipated within the framework of scenarios, i.e. quantitative and qualitative image of possible futures, whereas the probability of different paths possibly cannot be estimated seriously. In order to configure such images, an interdisciplinary team has been proven to be necessary, and at least at this point the question of institutions performing technology forecast comes into focus.

# 3 Think Tanks

So called think tanks, i.e. institutions which deliver studies, forecasts, material for supporting political and economic decision in a large scale, are not an invention of the 20$^{th}$ century. With a certain semantic flexibility one could call Plato's Academy to the earliest think tank. Plato founded his Academy in Athens when he returned from the Olympic Games in 387 B.C. It lasted 916 year when it was closed 529 A.C. by Christian Roman Emperor Justinian I. as a pagan institution. It was an exclusive "club", not a school in a narrow sense with teacher and students, but with a certain distinction between younger and elder members. Whereas mathematical and philosophical issues have been discussed, it is not farfetched to assume that the Academy played also a role as an elite training center with an impressive number of brilliant alumni (cf. Guthrie 1986, p. 23; cf. also Field 1996). Moreover, it can be imagined that political issues have been discussed with visiting politicians and widespread by talks and lectures given by members of the academy outside of

[6] Bacon 1859, pp. 523ff.; from an anonymous Elizabethan translation, in: Hansen (1978), pp. 485f., quote found in Morra/Smith 2006, p. 40.

[7] The original text of Roger Bacon 1859: "[…] nam instrumenta navigandi possunt fieri sine hominibus remigantibus, ut naves maximae, fluviades et marinae, ferantur unico homine regente, majori velocitate quam si plaene essent hominibus. Item currus possunt fieri ut sine animali moveantur cum impetu inaestimabili: ut aestimamus currus falcati fuisse, quibus antiquitus prognabantur. Item possunt fieri instumenta volandi, ut homo sedeat in medio instrumenti revolvens aliquod ingeninum, per quod alae artificialiter compositiae aerem verberent, ad modum avis volantis. Item instrumentum, parvum in quantitate ad elevandum et deprimendum pondera quasi infinita, quo nihil utilius est in casu. […] Possunt etiam instrumenta fieri ambulandi in mari, vel fluminibus, usque ad fundum absque periculo corporali" (Bacon 1859, pp. 532ff.).

its walls, too. The end was not caused by a physical destruction, but was rather a smooth dissolution (cf. Cameron 1969).

As another example may serve the learned *Académie putéane*, supported by the French families de Thou and Dupuy. It was a group of scholars not only ready to discuss literature and scientific topics but also public affairs.

> *"It was a prototype what we would call today as 'Think Tank'; a kind of a private office of experts who wrote basic papers according to their ideological inclination on demand of political and industrial forces" (Soll 2009, p. 45; transl. by the author).*

It served as a counseling office for the church, for scholars from Europe for the French parliament as well as for the French crown. The climax of its importance was in the middle of the 17th century. With the absolutist style of governance by Louis XIV the expertise of this academy has been substituted by government officials (cf. Soll 2009, p. 46).

In terms of current definitions, a Think Tank is seen as an addressable group of learned people with a considerable expertise, which offers basic papers, advice, problem solutions, networking and other scientific based services with respect to political, technical and economical decisions in demand by political, industrial and societal institutions. Such a group can be a free changing club of interested and weakly organized people or an institution, supported by foundations as well as an institute ruled by a state authority.

As a private institute, supported by grants and by Federal Authorities, the Hudson Institute advanced quickly to a paradigmatic prototype of think tanks and to become the most famous one. Its founder Herman Kahn (1922 – 1983) who came from the RAND Corporation was a mathematician and physicist, not an engineer or economist. Previously he was involved in the developments of the Hydrogen Bomb together with Edward Teller and Stan Ulam. The foundation time of the institute was 1961. This was a time in which the belief in technological progress and the trust into the computability of the world was deeply rooted. The RAND Corporation developed in the 1950s new military strategies as a consequence of nuclear weapons. It produced a new type of "civilian defense intellectuals" with no military or even war experience, but trained in applying methods of Operations Research, mathematical modeling and statistics (cf. Pias 2009). To develop a strategy for a thermonuclear war, classical military thinking was irrelevant:

> *"In fact, most of the strategists and technicians were so awed by the existence of this new weapon that they almost did stop thinking" (Kahn 1962, pp. 197f.).*

Kahn continued his "Thinking about the Unthinkable" when having founded the private Hudson Institute, but extended his activities to non military fields like societal, cultural, economic and technology developments. Nevertheless he continued to apply proven methods.

## 4 The Methods

For Kahn and his collaborators it was important to combine the history of interesting developments "with statistical techniques to create extraordinary sketches about the future" in a new way.

Such statistical techniques had been developed earlier such that Kalman-Filtering, Exponential Smoothing, Least Squares fits in order to extrapolate complex time series to a certain range toward future developments in cases, when the process of its generation is unknown, i.e. if there is no theory expressed in terms of mathematical equations and boundary conditions. To illustrate this, a least squares fit may serve as an example. Take a pendulum, one can extrapolate its behavior by finding the coefficients of a polynomial expression of degree n by calculation of them due to the condition that the sum of the squared deviations between measured and theoretical values should be a minimum for all $t > t_0$.[8] Using the polynomial expression found it is possible to calculate the values for any $t > t_0$. If one takes, like in Fourier analysis, a trigonometric function system, the result is easier to obtain, if an obvious periodic process is observed. With all these methods it is possible to calculate the increasing error probability of the extrapolated values for $t > t_0$ in dependence on the time distance $t - t_0$. The difference between using such an extrapolation method and using the knowledge from classical mechanics, that for a pendulum with a back force proportional to the deviation leads to simple harmonic solutions which can be calculated easily[9] and which delivers much

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8 As a textbook example cf. Wolberg 2005.

9 According to Newton $F = m\cdot a$, one has $-m\cdot(g/l)\cdot\sin\varphi = m\, d^2 (l\varphi)/dt^2$; for small $\varphi$ we have $\varphi \approx \sin\varphi$ with the solution $\varphi(t) = \varphi_0\cdot\cos(\omega + \delta)$ and with $\omega = \sqrt{(g/l)}$. The period is then $t = 2\pi/\omega$.

more reliable results even for great $t > t_0$. In other words: if there is no theoretical knowledge about the process, one attempts to find patterns in the available behavioral data. But this is not an explanation. Such approaches have also been developed by Norbert Wiener, the father of Cybernetics, when he tried to extrapolate possible flight maneuvers of military jet pilots under attack (cf. Wiener 1948). Under the assumption that systems tend to optimize their behavior according to minimal energy consumption or according to a minimal or maximal entropy principle, one can try to let a system run stochastically (i.e. a random walk in a state space model under constraints) in order to observe its dynamic development. This is some kind of experimental mathematics and a well appreciated simulation method. The advantage of this Monte Carlo Method (according to the casino in Monte Carlo) is that the run can be calibrated with empirical data – one can feed the model with experience. Hence a certain social dynamics can be modeled in cases in which no theory is available.[10]

Nevertheless, the Monte Carlo Method, preferred by Kahn's group due the historical reasons, had some disadvantages: It requires a model with variables of the same type in order to define a phase- or state-space in which the system can unfold its dynamic (timely development). Not all items of technology development as indicated in Table 16 are suitable to be formalized as continuous or discrete quantitative variable (on an ordinal scale) but sometimes only as variables on a nominal scale.

Thinking about future technologies can be performed in several ways. Table 16 shows some contemporary methods applied to the items listed above.

[10] Today there are a lot of journals dedicated to the applications of Monte Carlo Methods; for an introduction cf. Robert/Casella 2004 as a textbook example.

### Table 16: Synopsis of Methods for Prognosis of Technology Development[11]

| | Artefacts (instruments, devices) | Technical functions thereof | The organizational closure[12] | The ways of production, use, and waste management | The interactions with environment, economy, society, and politics |
|---|---|---|---|---|---|
| Trend analysis | | | | | |
| by extrapolation of time series[13] | Measurement of technical and economical performance[14] | | | | |
| by math.-statistical methods[15] | | | | | Market diffusion model[16] |
| by Delphi surveys[17] | E.g. for Germany supported by Federal authorities[18] | | | | |
| by intuition (qualitatively)[19] | Technology visions in literature and popular writings[20] | | | | |
| | | | | | |
| Simulation [21] | | | Early methods like System Dynamics[22] | | |
| | | | | | |
| Games[23] | | | | | Rather in the fields of marketing |
| | | | | | |
| Scenario techniques[24] | E.g. Nanontechnologies[25] | | | | Surprise free approaches |
| | | | | | |
| Wild card scenarios[26] | | | | | Preferred in this field |
| | | | | | |
| Roadmapping[27] | Strategic as well as prognostic statements[28] | | E.g. Ubiquitous Computing, future use of intelligent objects[29] | | |
| | | | | | |
| Participative Methods[30] | E.g. FORESIGHT Process in Germany[31] | | | | |

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11 This synopsis has been suggested by *noocleus ag foresight. innovation. strategy*. Limmattalstr. 38, CH-8049 Zürich, in www.noocleus.ch; extended and modified here; a critical approach to all those techniques can be found within the "International Journal for Forecasting".

12 I.e. all the technical and organizational co-systems necessary to unfold the technical function of a device.

13 See "Textbooks for Control Theory and Time Series Analysis", and Wiener 1948.

14 Cf. early Grupp et al. 1987; as example in communication technology cf. Gilder 2000; Starner 2002.

15 Cf. Armstrong 2001; Robert/Casella 2004.

16 Cf. Skiadis 1986.

17 Cf. Bell 1997; Loo 2002.

18 As an example for German Delphi studies cf. BMBf/ISI 1998 (= Delphi '98 with more than 1,800 scientists); BMFT/Grupp 1993; the topic were: information and communication technologies (ICT), service and consuming, management, organization of work and production, chemistry and new materials, health and live processes, agriculture and nutrition, environment and nature, space craft, and large scale experiments.

19 Cf. Liebl 1996, more general Steinmüller et al. 2003.

20 A good survey with respect to anticipating computer and communications technology is given by Friedemann Mattern (cf. Mattern 2007).

21 For mathematical methods cf. Pichler/Moreno-Diaz 1987; Zeigler 1976, 1990.

22 Cf. early Forrester 1961, still used and modified towards event oriented simulation methods with optimisation; cf. also Zeigler et al. 2000.

23 Cf. Oriesek/Schwarz 2008.

24 Cf. Fahey/Randall 1998; Godet 1987; Ringland 1998; Wilms 2006.

25 Cf. Grunwald 2009.

26 Cf. Petersen 1997; Steinmüller/Steinmüller 2003.

27 Cf. Farrukh et al. 2003; Laube/Abele 2005; Möhrle/Isenmann 2007.

28 Cf. Liebl 1996.

29 Cf. Herzog/Schildhauer 2009.

30 Cf., for instance, Gloede 1994; Jungk/Müller 1989; Weisbord/Janoff 2001.

31 The Foresight-Process, initiated by The Federal Ministery for Education and Research, Bonn-Berlin, Germany has coverd the following key future fields: (1) Human-Technology Cooperation: integrated research of human and technical sciences for closer human-technology interaction. (2) Deciphering aging: research for a better understanding of ageing as a key process involving multiple factors which takes place over a person's entire lifespan. (3) Sustainable living spaces: infrastructures for the living spaces of the future. (4) ProductionConsumption2.0: systemic innovations for sustainable forms of production and consumption. (5) Transdisciplinary models and multi-scale simulation: the simulation of technical, biological and social systems to handle the complexity in the natural sciences and the arts. (6) Time research: developing time-dependent technologies and processes in greater depth. (7) Sustainable energy solutions: early strategic bundling of the contributions of different research fields to the sustainable generation and utilization of energy; cf. http://www.bmbf-foresight.de [May 2010].

It should not be forgotten that all these methods are not using a theory in a strong meaning of this term, i.e. they cannot explain a phenomena in a deductive-nomological way. The model which is generated by the processing of empirical data is not a nomological model like the pendulum equation of motion. Hence, extrapolation cannot replace explanations.

The situation became worse when the mathematical effect of nonlinearity could be made visible on computers. Already the mathematician Henry Poincaré (1854 – 1812) could show that the characteristics of solutions of certain differential equations can change abruptly, if one changes either the starting conditions or some parameters.[32] Later this discovery had been made very popular by the impressive computer born visualization in chaos theory. Despite the mathematically determined dynamics of such processes, one cannot predict them earlier as when they actually happen. Here the description of the system is as long as the system's behavior protocol. Therefore a prediction ruled out from such a theory is useless. It is rather clear that possible, more sophisticated theories about societal, political, or economic processes are nonlinear theories (cf. Weidlich 2000).

For this reason, one has stopped to make explicit predictions in technology over more than five years. In Germany's Technology Assessment one is speaking about „futures of technologies" (in German "Technikzukünfte"). They are produced as models for scenarios and simulation. In contrary to a quasi objective approach, formerly common in Anglo-Saxon and U.S research, the storylines of technology futures depend strongly upon the implicit knowledge used by the model maker, the lack of knowledge and the subtle influence of the values and prejudices of the model maker (inclusive unconscious fears and hopes) on the generation and features of models. Particularly this holds for mid and long term models, e.g. nuclear fusion energy, energy consumption, traffic development, etc. Kahn recognized this very early and he tried to fight against a literal understanding of his results:

> *"Most of the calculations […] are intended as illustrative examples and metaphors, or as a basic communication, and not as a scientific proof" (Kahn 1960, p. vii, quotation from Pias 2009, p. 15).*

All images about futures are sensible for ideology (cf. Grunwald 2009; Kaiser et al. 2009). Thus the uncertainty involved, together with the necessity to make assumption and hypotheses, endangers the models to become a tool for particular interests, for instance to promote certain technologies. Hence, there cannot be a strict neutrality of such models.

Kahn and Wiener tried to show that the trend runs into a sensualistic culture. This unusual term may be understood as an inclination towards more empirically supported knowledge and convictions, "this-worldly, secular, humanistic, pragmatic, utilitarian, contractual, epicurean or hedonistic cultures" (Kahn/Wiener 1967, p. 39). Adapting Pitirim Sorokin (cf. Kahn/Wiener 1967, pp. 43f., adapting Sorokin 1970, pp. 84ff.) in Table XV, one may find values of the three systems of truth (ideational, sensate, late sensate) and it is not farfetched that the Hudson group rather tended to sensate respectively late sensate value system.[33]

The German experiences in this field with respect to methodological and institutional issues in Innovation Research, Future Research and Technology Assessment for prospective technologies showed the limits and the possibilities of forecasts and methods thereof.[34] It is clear that due to the limited reach of forecasts about technology development, the reach of an evaluation thereof must be limited, too. The same applies to retrodictions: History of Technology allows an evaluation of the past technology development only in so far as this technology can be reconstructed not only in function, but also in use (cf. König 1988).

## 5 Kahn's Prognosis and Its Presuppositions

The emphasis of Bacon together with his impetus on enlightenment can be found again in Kahn. Whereas Bacon tried to remove fears about technology misunderstood as occult practices, Kahn aimed at strict for-

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32 The first hint is the famous paper of Henry Poincaré (cf. Poincaré 1890).

33 These are: cynical, disillusioned, nihilistic, chaotic, blasé, transient, superficial, weary, sophistic, formalistic, atheistic, trivial, changeable, meaningless, alienated, expedient, and absolutely relativistic; cf. Kahn/Wiener 1967, Table XV, p. 43.

34 The actual methods of Innovation Research, Future Research, Technology Assessment and Trend Analysis are well known as well as their limits; cf. for Technology Assessment Grunwald 2002; for limits cf. for example Gausemeier et al. 2009; Grunwald 2000; Kornwachs/Meyer 1994; for an early synopsis of methods cf. Geschka 1995, as a modern example for foresight-methods may serve Angerer et al. 2009.

mal rationality, explaining the world as a result of optimization processes. He was the first who reflected radically all consequences of the policy of deterrence: So he became famous as the inventor of the "doomsday machine": A computer is connected with a set of distributed hydrogen bombs. If the computer model comes to the result that a Soviet attack is occurring, it starts to ignite the hydrogen bombs that will destroy the world and annihilate all human life by the radioactive fallout.[35]

Kahn, about 1952, was involved in the development project of a hydrogen bomb. He worked together with John von Neumann, and improved the Monte Carlo simulation procedure by simplifying it considerably with better accuracy than before.[36] Later he worked with the RAND Corporation at the problem of military strategies and developed concepts like "Credible-First-Strike Capability" and "mutual assured destruction" which became leading ideas during the Cold War.

It is necessary to know about this background in order to estimate the consequences of the following activities. 1961 Kahn founded together with other scientists the Hudson Institute, New York. They served as counselors of the Department of Defense, but they applied their simulation methods on civil contexts, i.e. on the development of technology, politics, economy and possible mental developments. Kahn's basic argument was:

> *„But the fact that a certain prospect is not easy to contemplate does not mean that it will not occur" (Kahn/Wiener 1967, p. 367).*

In this context the forecasts in the book „The year 2000" about technology development had been made thirty-three years ago. They are embedded into a far reaching analysis of political and economic development. The project had been supported by the American Academy of Science, chaired by Daniel Bell. The project committee of the Hudson Institute put the issue forward with the announcement that here "the new techniques of the think tanks" could be demonstrated.[37] Kahn and Wiener traced back "basic trends of Western society […] as far as the twelfth or eleventh centuries" (Kahn/Wiener 1967, p. 7). These trends had been categorized into thirteen "rubrics", and these time series have been extrapolated with respect to their mutual interaction for the next 33 years (cf. Kahn/Wiener 1967, pp. 7f.).

For Kahn the development of technology can be modeled by surprise-free approaches (see Chapter 2.3). Thus they used scenario techniques in a – today seen – naive approach by looking for standard variances of the trends. Nevertheless they emphasized:

> *"For most of the projections that we are discussing, in which we are looking twenty to thirty or more years ahead, perhaps the most surprising thing that could actually happen would be the absence of surprises. Therefore here is no implication that a surprise free projection is likely" (Kahn/Wiener 1967, p. 38).*

Within the framework of such a surprise-free world it was possible for the authors to extrapolate technological trends with respect to some key indicators of technological development like patent analysis, research budgets, etc.

## 5.1 The Highly Probable Forecasts

Today we could check this list of a hundred possible technology lines in a know-it-all attitude and look for hits and misses, since we are living in 2010 and we know which technology has been put into practice in the meanwhile. Nevertheless there is no reason to be malicious – we have to regard the time in the 1960s of uncritical belief into the power of pure technological solutions of any problem. Moreover, Kahn had had the courage to publish such prognoses.

The rate of hits is not so bad. Kahn anticipated a long term trend (cf. Kahn/Wiener 1967, Table I, p. 7), composed by an increase of sensualistic and hedonistic forms of culture, by the formation of high perform-

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[35] This was parodied by the famous movie "Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb" by Stanley Kubrick, USA 1964; cf. also Kahn's writings about thermonuclear war and "doomsday machine" in Kahn 1960, 1962.

[36] The Monte Carlo method uses random number generators to produce a random walk in a state space configuration. Thus one can observe whether the system develops characteristic patterns of dynamics. These patterns can be interpreted as trends. Nevertheless, if a trend can be shown, there is no guarantee that it will persists in the next time. One has to introduce the hypothesis that system dynamics is running without too big "jumps"; cf. Robert/Casella 2004.

[37] Cf. front cover of the first issue Kahn/Wiener 1967; cf. also Cohen 2009.

ing elites in bureaucracy, "meritocracy" und economy, a world-wide industrialization and modernization which we describe today as globalization, increasing welfare, growth of world population, urbanization, and the decreasing importance of primary or classical occupations (cf. Kahn/Wiener 1967, Table I, p. 7), which we designate today as "flexibilization" (cf. Sennet 2006).

In Table XVIII Kahn and Wiener listed 100 innovations from which they assumed a highly probable realization in the last third of the 20th century. If one compares the list with the technology available in the year 2000, one could find about 20 percent as hits. They are summarized within Table 17.[38]

[38] Such comparisons appear from time to time; cf. Cohen 2009; Haaf 1998; Wallenchinsky/Wallace 2010, and already early Jungk 1969. A new retrospective article I just learned after proof- reading; c.f. Albright 2002.

**Table 17: Comparison of Prospects of Technologies**

| Forecasts by Kahn and Wiener[39] | State of Technology about the Year 2000[40] |
|---|---|
| Multiple application of lasers (1) | Since the 1970s lasers became a general and universal tool for material treatment, surgery, communication and many other fields |
| New or improved materials for equipment and appliances | Ceramic technology started broadly in the 70s |
| Extensive and worldwide use of high altitude cameras for mapping, prospecting, census, land use, geological investigations (11) | Google Earth (started 2001), but before Satellite photography with high resolution (15 cm) |
| Inexpensive design and procurement of „one of a kind" items through use of computerized analysis and automated production (20) | Compare the actual variance of car types of the same class (like Golf II in Hall 54 since 1983) |
| General use of automation and cybernation in management and production (28) | Computer Integrated Manufacturing (CIM) has expanded since 1985 with changing success |
| Extensive and intensive centralization (or automatic interconnection of current and past personal and business information in high speed data processors (29) | Computer search in criminology since 1979 |
| Other and new possibly pervasive techniques for surveillance, monitoring and control of individuals and organizations (30) | Surveillance cameras in public areas, bugging operations, electronic eavesdropping to a wide extent |
| More extensive use of transplantation of human organs (50) | Since 2000 nearby all organs |
| Commercial extraction of oil from shale (67) | Pacific Petroleum Company (SPPC) presented in the beginning of 80ies the production of synthetic oil from shale |
| Simple inexpensive home video recording and playing (70) | Home video recording after 1975, broadcasting by world wide web since 2004 (Face book) |
| Inexpensive high capacity worldwide, regional and local (home and business) communication (perhaps using satellites, lasers and light pipes) (71) | Digital communication by ISDN, DSL, by cell phones, interactive laptops etc. |
| Pervasive business use of computers for the storage, processing and retrieval of information (74)<br>Shared Time (public and interconnected?) computers generally available to home and business on a metered basis (75) | Nearby no working place is without with a computer.<br>The rise of World Wide Web since the 1990ies allows all this |
| Other widespread use of computers for intellectual and professional assistance (translation, teaching, literature research, medical diagnosis, traffic control, crime detection, computation, design, analysis and to some degree as intellectual collaboration generally) (76) | 1992 there has been over 1 Million connections |
| Personal pagers (perhaps even two way pocket phones) and other personal electronic equipment for communication, computing, and data processing program (80) | Handy, Palmtop, Black Berry, I phone |
| Direct broadcast from satellites to home receivers (82) | In Germany possible since 1985 |
| Inexpensive (less than $20), long lasting, very small battery operated TV-receivers | Introduced in Japan 1970, but not very successful |
| Home computer to „run" household and communicate with outside world (84) | First PC was Altair 8800 (1975, USA) |
| Conference TV (circuit and public)(90) | Videoconference is used and well known, introduced as Picture phone 1969 (USA) |
| Flexible penology without necessarily using prisons by use of modern methods of surveillance, monitoring, and control (91) | The first electronic feet chains by a sentence 1983 in Albuquerque, New Mexico, USA) |
| New biological and chemical methods to identify, trace, incapacitate, or annoy people for police and military use | Complete human DNA Analysis, based on work in 1985 |
| Extensive use of „biological processes" in the extraction and processing of minerals | In state of exploration and extended tests |

Source: given by Kahn/Wiener 1967, Table XVIII, p. 51-55, with their occurrence around the year 2000 (only hits)

[39] Cf. Kahn/Wiener 1967, Table XVIII, pp. 51-55; numbers in brackets relate to the numbers of the entries within the table.

[40] Done by a cursory internet investigation and using in Bullinger 2007.

In Table XIX (p. 56) Kahn and Wiener count 25 less likely technological developments like "true artificial intelligence, up to planetary engineering or some direct control of individual thought process. Here the hits are only (more or less):

- Effective chemical or biological treatment for most mental illnesses (6). This may occur today to a certain degree.
- Major rejuvenation and / or significant extension of vigor and life span say 100 to 150 years (13). It is true that the life expectancy of girls born today (2010) may run up to 100 years in high developed countries with respective medical facilities.

Then a list of ten radical or far out possibilities that are quite unlikely follows. There is no hit anymore (like complete genetic control, interstellar travel, and practical use of extrasensory perception, only to mention a few).[41]

## 5.2 The Misses

Whereas the rate of hits goes down in case of predictions announced as less likely (10% respectively to zero), it might be interesting which prognosis was no hit. In a cross check on can find predictions in the tables mentioned above that are far away from any realistic chance to be true.

In Table XIX one can see that there are three cases: H = hits (only two, see section above), ID = technology not yet available but in discussion as a desideratum, OoD = neither available nor in discussion.

- ID (1) Artificial Intelligence has yet failed its aim to produce conscious agents; in discussion as a desideratum.
- ID (2) There is no controlled fusion device available (perhaps within the next 50 years).
- ID (3) Artificial growth of tissue is possible, but not growth of organs or limbs.
- ID (4) Superconductors are available up to 263 Kelvin, but not at room temperature (cf. Tripodi et al. 2007).
- ID (7) There is not yet a complete control about heredity changes. With human genomes manipulations are forbidden (germ line therapy).
- ID (9) Practical materials with theoretical limit strength are not available, but new materials with additional physical properties due to Nanotechnology.
- ID (11) Direct input into human memory (banks) is in an experimental state.
- ID (12) Augmentation (today called as enhancement) of human mental capacity by interfaces is in an experimental state.
- ID (15) Automated Highways could be made, but it is not yet accepted.
- ID (17) There are no moon or planetary stations yet.
- ID (18) Cheap electricity for 0.3 cent per Kilowatt hours is not available.
- ID (22) Laboratory Conception and nurturing of fetuses (animal and or human) is not yet possible.

ID (25) Control of individual thought process is not yet available, but brain research is proceeding in identifying thoughts with neuronal processes.

In case of ID classified predictions one could state that technology has made less progress than expected. One should consider the time in which these predictions were made. If the leading idea is acceptable that we tend to describe processes and things not well understood in terms of what we believe we know already, particularly in terms of our actual available technology, there is no wonder that in a time of exploding technological progress this experience is subject to prolongation models. Beside this, the real economic weight of high tech branches is smaller than one believes: For instance, Silicon Valley employed at its climax ca. 1/3 of a percent of U.S workers. Another reason for the wrong estimations could be that exponentially growing curves will not keep their form in eternity. There is no infinite growth in real systems and therefore a better model would have been a logistic curve with saturation effect. The predicted doubling of life standards (cf. Kahn/Wiener 1967, Table IX, p. 25, entry 10, and Table VII, p. 23, entry 5), together with a reduction of work time up to 30 hour week didn't take place (cf. Kahn/Wiener 1967, pp. 193ff., p. 257).

- OoD (5) Airplanes, not rockets, are the carrier for transports, beside extraterrestrial shuttles to only one orbital station. SÄNGER Project in Germany has failed to be started in 1980s.

[41] Cf. Kahn/Wiener 1967, Table XX, pp. 56ff.

- OoD (8) No hibernation of death in order to make a suspended reanimated.
- OoD (10) Far away to convert mammals to fluid breathers – out of discussion.
- OoD (14) Chemical or biological control of character or intelligence is neither available nor accepted.
- OoD (16) Moving sidewalks for pedestrians is only available at some airports, but not generally.
- OoD (19) Extrasensory perception is scientifically contested and not applicable.
- OoD (20) Planetary engineering (space crafts) only in nearby orbit.
- OoD (21) Modification of solar system is illusionary.
- OoD (23) Drug equivalent to Huxley's soma (kind of happiness drug) could be available, but not accepted.
- OoD (24) Use of telepathy, see (19).

In case of proposals, classified above as OoD (= Out of discussion), the reasons for their failure seem to be a wrong estimation of the state of research and technology themselves. Moreover, such technologies are neither pursued since the 1960s nor have they been subject of public discussion and widespread desires or demands.

## 5.3 The Reasons for Hits and Misses

Here we can observe a euphemistic thinking that is fixed on the contemporary technical possibilities. The categories for extrapolation are frequently the "better", "more extended", "more far away" "less expensive", and "more efficiency", that allow extrapolating seemingly trends in a linear or exponentially smoothed way. Kahn and his collaborators called these applications a surprise-free approach. Of course events, also determining technology developments and investment decisions to foster the one or other technology, like Oil crises in 1973, Chernobyl 1986, the ecology movement since the early 1970ies, the breakdown of Berliner wall, the introduction of Euro, the both Gulf Wars 1992 and 2003 or 9/11 in 2001, could not be foreseen, of course. Even if one would apply the Wild Card Method indicated in Table 16, there is no guarantee that the "right" wild card has been chosen. Unexpected events may happen and one can only make an image about what would be the sort of consequences, if something unexpected of a certain type[42] would take place.

On the other hand, Kahn called seventeen causes for surprising changes (cf. in Kahn/Wiener 1967, Table VIII, p. 24.) Beside the "Wild Cards" (8) (Doomsday machine), ((14) new mass religions, ideologies or (17) philosophies) one can find on Table VIII on page 24 near by all events that took place between 1967 and today: The four apocalyptic riders (War, Revolutions, Famine, Pestilence),[43] Despotism, finance depressions, small nuclear weapons, revival of fascism (in the 70s in Latin America), Racial, North-South, Poor-Rich conflicts, economic dynamics of China,[44] political dynamics in US, USSR, Japan or West Germany,[45] new ideas in religion, philosophy or mass movement,[46] development of world-wide organizations, e.g. the rise of NGOs and others.

Despite these wild cards (not called as such in Kahn Wiener's diction), the authors of the Hudson study could not imagine how many changes in global dynamics would happen due to the structural change in stock markets as well as in media development, in international terrorism or in international communication generated by the convergence between telecommunication and computer technologies. This is much more astonishing since we can find a nearby precise prediction about the World Wide Web:[47]

> *"Eventually there will be probably computer consoles in every home, perhaps linked to public utility computers and permitting each user his private file space in a central computer, for uses such as consulting the Li-*

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42 It is always possible to classify catastrophes like finance crisis, epidemics, armed conflicts, earthquakes, storms, fleets, tsunamis, abrupt climate change, breakdown of markets, civil wars, terroristic attacks, breakdown of world-wide nets according to the winner and losers of such events. Even technological breakthroughs know winners and losers, since new technologies substitute old ones and require new qualifications and a lot of adapting work.

43 As pointed out by the authors, cf. Kahn/Wiener 1967, p. 23; cf. also Apocalypse 6, 1-8.

44 Kahn estimated an economic growth of China with 10%, in 2007 the rate was about 13% growth of the GDP; cf. www.chinaview.cn, January 14, 2009.

45 Set into reality by reunification of Germany, the dissolution of west-east block dichotomy, fall down of communism etc.

46 Given by the ecological movement, the reinforcement of Islam as well as other religions.

47 Cf. also Kahn/Wiener 1997, Table XVIII, pp. 51f., Numbers (71), (74), (75), and (76).

*brary of Congress, keeping individual records, preparing incoming tax returns from these records, obtaining consumer information"(Kahn/Wiener 1967, p. 90.).*

According to Marsha Cohen,

*"Kahn and Wiener's projections of income failed to take into account the consistent and the growing inequality of income distribution in spite of overall rising GNP […] that would occur not only in the developing world but within the U.S. during the last third of the 20$^{th}$ century" (Cohen 2009).*

This applies to Europe and other industrialized countries, too. Further on, the authors don't consider the effects of contraceptive means upon the world population growth, the effects of migration movements from developing countries into US and Europe, and the world wide effects on the labor market due to the outsourcing strategies of enterprises (cf. Cohen 2009).

Nevertheless, the new is not as new as it appears at first glance or even in forecasts. Insights into future developments, even those with surprising effects, are based on contemporary thinking and contemporarily available conceptual categories. Even if one tries to violate them in order to think against the habits (in German "querdenken") we cannot avoid using these categories when negating them. Looking back one can see that the current development has not been caused by abrupt technological breakthroughs or spectacular inventions. Rather there have been incremental, small improvements. The application thereof are mostly triggered by external factors like individual ambitions, scientific interests, acceptance by clients, political and cultural constraints up to habits in design, procedures, organizations and their management. Additionally, one has a certain cultural mood whether the strain to the new is seen positively or not, whether the inventors and discoverers can count on fame, honor, acknowledgement, and rewards. This may be a pressing question whether the greed for the new as such will be substituted by thinking on recycling and sustainability. But even here there is always the newest technology of waste management.

## 6 Acting with Insufficient Knowledge

If things would run smoothly, we could limit us on extrapolation and well calibrated simulation. The usual background for acting with technology is the well known mean-goal relation. The common work of engineers is to find a suitable means for a given goal. The user usually finds out that a given means (say an available product) can always be used in a way not intended by the inventor (in German "nicht im Sinne des Erfinders"). Therefore we say that a mean can produce new goals when being used, and – the other way around – each goal can be met not only by one but by an inestimable number of means. The abrupt changes – if any – happen mostly in the change of goals in relation to an already existing technology. Thus, the ARPA net was not designed for civil use; the main frame computer was not a toy, the MP3 Code was originally developed for professional use of reporter's audio line to broadcasting studios.

We try to predict the future in order to control it. We know that our knowledge, won by forecasts, is necessarily incomplete. Nevertheless we have to plan our actions and to design our future living conditions in a closer or more far away horizon. This trivial insight doesn't prevent us to model future images, knowing that they must be painted over permanently like a weather forecast must be overwritten and readjusted each hour. Only a few developments can be foreseen with good accuracy: for instance demographic dynamics (the aging distribution of population in industrialized countries). Nevertheless in this case the dynamic has been known by experts in the 1980s, and first conferences had been initiated,[48] but a broader public discussion about this fact just increased in the beginning of this century by some popular books with no scientific claim. Another long term problem with no solution in sight is nuclear waste management. A lot of new approaches are in a test phase but there is no breakthrough known.[49] Another example is the knowledge

48 First German Conference, initiated by the Federal Ministry for Research and Technology in Bonn, Germany about this issue, was held in 1992 "Alter und Erwerbsarbeit der Zukunft"; cf. Bullinger et al. 1993.

49 The usual way is currently a transient geological disposal. A space disposal seems to be too expensive and too risky, considering the launch phase of a space vessel. Methods for transmutation (i.e. radiation stimulated acceleration of the decay) or re-use (e.g. radio-isotopic thermoelectric generators as small energy suppliers) are still in an experimental stage.

that curves of exponential growth tend to go to a logistic saturation some day. Thus the end of the contemporary techniques in silica can be predicted in principle, but not the time, when exactly it will happen.[50]

As Kahn and Wiener argued, the study "The Year 2000 is not an exercise in prophecy; it is an effort to sketch the constraints of social choice" (Bell 1967, p. xxviii.). Beside its function, to be "a framework of speculation" (Bell 1967, p. xix), the study of Kahn and Wiener could teach us about the purpose and usefulness of such projects. Events like the Iranian Revolution, the range of international terrorism, several political decisions, leaving behind the system of Bretton-Woods toward a market led system in the 1970s which started the globalization process with respect to finance, can be seen as boundary conditions for a lot of socio-economic developments that influenced the technological development by changing the conditions for investors. Thus the main deficit may be that the interdependence between technology and political as well as economic developments had been underestimated due to technology oriented thinking. One can feel the fear of the authors that there might be unforeseeable factors that would prevent a continuous prolongation of this American Way of Life. Another fear was that the trend to a more hedonistic, leisure oriented postindustrial society "would corrode the work ethics of the American middle class" (Cohen 2009). This happened neither in the US nor in other industrialized countries, but the world wide ageing, joblessness and the scarcity of jobs which earn a sufficient income, have increased.

To sum up, "The Year 2000" didn't provide an "early theory" about sociology, industrial dynamics, technology development or even about making policies in a complex and fast changing world. But it tells us to regard more than earlier the dictum of Socrates that we should know, that we don't know, or in more pragmatic way: every prediction, if made as carefully as possible, tells us something about its own limitations. It enables us to make our newest mistakes much more precisely.

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[50] This relates to the discussion about the so called Red Brick Wall. The four laws of Moore are: 1. The doubling time of function items per chip each 1.5 years still holds (cf. Moore 1965); 2. Doubling of the cost for a chip plant all four years (cf. ITRS 2003); 3. Energy consumption and resulting cooling need increase exponentially to the density of circuit units (cf. Fettweis/Zimmermann 2008); 4. Each generation of new software doubles the number of commands (lines). Taking this together, one will have no further potentiality to increase the efficacy with this technology. The Red Brick Wall denotes the stop of growth with this technology. Therefore there is an urgent need for new concepts, materials and new procedures for performing algorithms; cf. also Moore 1965; Paradiso/Starner 2005; also discussed in Kornwachs 2007a.

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# On Environmental Scanning, Emerging Issues Analysis and Construction of Wild Cards

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## 1 Introduction

This article argues for giving more weight to foresighting than to forecasting efforts in "futuring". Briefly, that means abandoning improvement of the probabilistic efforts in favour of multiplying scenarios in the centre of "futuring". The article outlines some developmental steps and characteristics of what is called environmental or periphery scanning, emerging issues analysis (EIA) as well as wild cards construction and shows that the complexity of issues on the periphery has brought environmental scanning and wildcards construction both into some conceptual trouble and some promising developmental states.

## 2 Environment Scanning and the Emerging Issues Analysis (EIA)

Environmental or periphery scanning is an effort to identify and assess what happens on the periphery. Significant changes in the world surrounding the agent, let it be an organization, group or individual are important. With environmental scanning the "What don't we know that might matter to our business?" question may get equal importance with the central problems that are focused upon. George S. Day and Paul Schoemaker stated not long ago: "The biggest dangers to a company are the ones you don't see coming. Understanding these threats – and anticipating opportunities – requires strong peripheral vision" (George/Schoemaker 2005, p. 135). They refer to the analogy of vision and its historical evolution. They refer to the need that, besides focusing, peripherical vision should simultaneously be strengthened. They conclude that the economic players seem to be backward in their evolution in comparison to biological evolution in which peripherical vision has been developing very strongly beside focusing, essentially contributing this way to survival. It is worthwhile to capitalise on this analogy in times of growing environmental turbulence.

The activity itself is called by different names: "environmental scanning", "periphery scanning", "horizon scanning" (the literature uses them as equivalents, so do we). As an activity in human history the origin of environmental scanning is probably traceable back in history, although it seems less in the history of economy and management. Reflexive literature in economics and management traces the awareness and analysis of the activity back to the end of the 60s. It is referred to Francis Aguilar who suggested horizon scanning to diminish the random character of the incoming information and make early warnings of changing external conditions (cf. Aguilar 1967). A typical classification states: "Environmental scanning has three foci. The first is the immediate environment (of current and immediate concern to the organization), the second is the probable environment (not of immediate concern to the organization but likely to be in the future) and the third is the possible environment (weaker signals on the radar screen which might turn out to be a seagull or a super tanker)" (Terry 1977, p. 2).

Integration of environment scanning into the information gathering activity necessarily changes the narrow questions having put by the agent, be that a firm, a governmental organization, or an individual, when it concentrates only to "issues in focus". Actually, a varying area will be identified important as environment for the agent's activity, depending on the changes outside and inside. With this the learning to be made by the agent will be differing too. With the growing complexity of the issues often the type of "uncertainty", the type of incertitude changes as well.

Sometimes abrupt changes occur suddenly in a sphere that became environment. Day and Schomaker give a striking example from their own practice to something that became decisive in the environment of their topic as quite an abrupt event but not anticipated by them. "In the early 1990s, one of us was helping the Venezuelan oil company Petróleos de Venezuela SA (PDVSA) construct future scenarios. The usual unknowns, from oil prices to export markets, received much of management's attention. But what actually transpired in Venezuela was never envisioned in any of the scenarios. The emergence of the populist leader Hugo Chavez, who would take on the establishment, declare martial law, nationalize the oil company, and fire all the top executives one Sunday afternoon during a national TV address, was an 'irrational' scenario"

(George/Schoemaker 2005, p. 148). They made several mistakes. The reconsideration of the political dimension was not included into the topic of their analysis because it was thought to be stabile, they did not count on the victory of Chavez and did not estimate the possible consequences of this for the Venezuelan oil industry. At least one of these dimensions did not reach their horizon: it was not identified as an environment in which decisive abrupt events may occur in relation to their research topic.

Having felt the partly chaotic state of some futures studies approaches concerning what environmental scanning was 15 years ago Trudi Lang provided for a profound metaanalysis of environmental scanning, issues management and emerging issues analysis (EIA) with a comparative aim (cf. Lang 1995). Lang compared four activities, Delphi, environmental scanning, issues management and emerging issues analysis (EIA) as having in common the aim of surveying the environment to determine likely issues that are going to impact upon an organization, community or individual. As she interpreted it, although they are similar in this regard, they do differ on what she called the urgency of the issues to be focused on. She emphasised the special importance of environmental scanning. Referring to Eleonora Masini, one of the leading persons in developing foresight already in the 70s she stated: "This process helps institutions allocate their resources in a way that anticipates or responds to changes in the external environment. Masini (1993, p. 102) herself describes the process as 'an outside in one that substitutes the inside-out perspective of forecasting and planning.' Originally used for economic trend purposes, it was broadened to include technological trends, and social and environmental factors in the 1970's" (Lang 1995, p. 9).[1]

We see from the cited place that Lang, following Masini, refered to some important change in the perspective that occured within environmental scanning. It is the outside-in focus that substitutes the inside-out perspective. This is in correlation with, consequence of the emerging turbulence of the economic, etc., environments, the growing penetrability of the boarders of organizations and some other factors. Giving first place to recognize outer trends and the interactions of these trends as decisive environment made environmental scanning an essential element of forecasting and that way of planning.

It is obvious that we have a meaningful multiplicity of issues and choices to term what we intend to understand as environmental scanning. First we can refer to the whole process when environmental scanning and analysis is made. Then "environmental scanning" is more general than emerging issues analysis. The Australian group, Thinking Futures, in 2005, defines that way that "environmental scanning in a strategic sense is about building a global context for your work, your organisation, your competitive environment and your industry. It is about recognising that the future is unlikely to be anything like the past, and that we therefore need to spend some time understanding the trends and likely influencers on the future of our organisations" (Conway 2009, p. 5). This is an important reminder even when telling that "the future is unlikely to be anything like the past" may be just some problematic metaphor. Second, we can speak about scanning as nothing but information gathering contrasting it with analysis and can narrow down the reference of the term. Both usages have their advantages. We have to recognize that the vague characterisation "that the future is unlikely to be anything like the past" gathers very different possible issues. Differentiating among them will be one way of progressing in the interpretation of environmental scanning.

So, thirdly, we can contrast environmental scanning to emerging issues analysis (EIA). Further it is very important to clearly differentiate among different types of emerging issues, for example concerning their predictability or abruptness, etc. We give different references and meanings to the term in these cases, we speak about different issues without the obvious signs that they still belong to the same class, when we do not take into account their differences. Common may be with all of them that they are different from simplistic trend analyses. All the different usages are realised in the literature, mostly with not much care for keeping them clearly differentiated. Lang herself, for example, notwithstanding her commitment to providing for exactness, used the term in three meanings, as "scanning in general", as "nothing but scanning" and as dealing with "less urgent issues".

We can contrast trend analysis and emerging issues analysis. It is worthwhile to indicate their difference with using different terms. Lang correctly says that while trend analysis is looking for issues that are about to become mainstream or are mainstream, actually, emerging issues analysis seeks to identify possible trends, from the periphery, that have not yet emerged, and may never fully emerge. She leans on the S curve pattern characterisation of transitions, she looks at transitions as processes generally following an S curve. But it is meaningful to think that S curves may not generally characterise all the transition processes. EIA refers, according to the S curve type interpretation, to the analysis of the starting part of the S curve.

[1] Lang refers to Masini 1993.

At this starting part, the shape of the curve is still partly undefined. Besides using the S curve interpretation she referred in her meta-analysis to the, alleged, low probability character of the realisation of some definite process when she spoke about this part of the S curve. We return to the question if the belief that a probability characterisation at all can be generally given to emerging issues is not somewhat reductive and derailing concerning the very early phases of the most different transitions and whether it should be tried at all.

"Environmental monitoring, environmental scanning gets special importance for strategic planning, when looking for weak signs may be of decisive importance. This is the place of 'emerging issues analysis' (EIA). EIA dates back to the end of the 70s, to Graham Molitor's work. Shortly, EIA was some trial to extend the forecasting perspective to emerging issues", said Lang. She assessed: "Following the same notion of issues management, emerging issues analysis (EIA) tries to also determine likely issues that are going to develop […] The major difference between the two is the focus on the stage of development of the issue – or in EIA terms, the point on the S curve" (Lang 1995, p. 13). Lang correctly referred with this to the origin of EIA. That was the intention "to extend the forecasting perspective to emerging issues". But she disregarded that emerging issues, at least a most important part of them, may be different by their essence from stabilised trends. This disregard is the result of trying to frame the issues of emergence by trying to keep the most possible continuity with framing trends. To put it differently, this is the result of trying to conceptualise emergence within forecasting and give them a probabilistic characterisation and with this step still stick to some but weakened prognostic claims. (The idea that at the beginning of the S curve there are still alternatives is submitted to the probabilistic trial.) Obviously, foresight trials, by abandoning the primacy of prognosis and so the probabilistic framing, lead to a less reductionistic, less narrow belief about the possible nature of emerging issues.

Notice please that Lang painted the picture by differentiating between emerging issues and developed trends. This is important. But we can ask if S curves may represent all the possible emerging issues? And whether it is a simple perseverance of metaphors when she speaks about the partly undefined nature of the beginning of the S curve? It seems that reducing the perspective to referring changes exclusively by the S curve is a somewhat misleading myopia, a trial to preserve something from thinking in continuities. When we embed EIA among the tools of forecasting then EIA is just a trial to extend the commitment of periphery scanning to make predictions to the process of emergence and early development. Appreciating the work of Molitor concentrating to EIA already in the 80s Lang stated: "It is argued that any public policy issue culminating in public action, especially in legislation, can be plotted on this S curve. The importance of this is that a reasonably reliable forecasting tool exists to enable organizations to anticipate future public policy issues and possible responses (cf. Molitor 1993). This is certainly one of the main reasons for issues management gaining popularity in corporations. However, unlike issues management, EIA sets out to monitor and detect likely emerging issues as early on in their gestation as possible" (Lang 1995, p. 14). To repeat: how far is it meaningful to reduce the perspective of EIA to "likely emerging issues"?

We find a hint here to the very basic ontological vision of the imagined dynamic. This is that processes change from consecutive incremental changes (long term equilibriums) to a different sort of consecutive incremental changes (from one stable process to another stable process). By now it is one of the most urgent tasks to critically re-examine this basic ontology as general background. To this ontology a second ontology (vision) is added about the nature of transition. According to this vision there is a special continuity in every transition. Just that continuity is expressed in the S curve like shape. One can guess that keeping to the S curve metaphor may be for example a methodological decision: to be able to make predictions about the transition processes needs the S curve-like behaviour to be the essential element of transitions. But we have to go further and include into our focus abrupt changes too even when the inclination to prediction should be given up with this step. Obviously an up-to-date EIA should conceptualise breaks, abrupt changes, too. This would make EIA, instead of a refined, extended forecasting effort, a genuine tool for foresight. Following the intuition that leads thinking in this respect "really" wild cards would inform us about these possible breaks. It seems time that futurists engage with the ontology of "endless transition" already, in which equilibriums are the exceptions and place abrupt changes appropriately in that vocabulary.

It is time to make a short interim summary. EIA was originally developed to embed it in forecasting, to extend the method of forecasting, rooted in probabilistic thinking and the ontology of long, stabile processes, the equilibriums and trends to emerging issues. Concerning EIA there is a very important development from the end of the 60s but this development has been simultaneously restricted. Issues analysis extended to, better to say gradually turned to emerging issues, trying to characterise them by probabilities, even when looking perhaps only for qualitative characterisations in a probabilistic vein. But the epistemic task itself, concerning catching the whole territory of "uncertainty", is not brought into a different level with this. In congruence with some of the newest research, why should we believe that a revised and extended predictive effort, aiming at more exact prediction of probabilities on the periphery would really be enough to uncover the whole set of "uncertainties" concerning the environment? If we think we should not believe this and guess that the observed growth in turbulences urges to radical changes in environmental scanning and EIA then to develop a different type of EIA becomes a most important task.

## 3 On Abrupt Changes and Wild Cards

We have a term to help opening the way. Perhaps wild cards construction is the essential step to make EIA able to more widely look for and interpret "uncertainties". EIA was first set and has been partly developing in the spirit of forecasting, devoted to search for probabilities or at least plausibilities. That means a restricted answer to the "what if?" question. For Lang, representing many to whom EIA and construction of wild cards is essentially the same activity, the difference is that EIA is the cognitive process while a wild card is the cognitive result. It seems that the first definition of wild card provided for by three important institutes in the early 90s was based on this same opinion. "A wild card is a future development or event with a relatively low probability of occurrence but a likely high impact (on the conduct of business)" (BIPE et al. 1992, p. v, cited by Steinmüller 2003, p. 4).

The keyword "Future studies" in Wikipedia referring to the World Future Society's Manual puts wild card construction as the fourth essential issue "futures studies" deals with. "Futurology or 'futures studies' is often summarized as being concerned with 'three Ps and a W,' or possible, probable, and preferable futures, plus wildcards, which are low-probability but high-impact events, should they occur. Even with high-profile probable events, such as the fall of telecom costs, the growth of the internet, or the aging demographics of particular countries, there is often significant uncertainty in the rate or continuation of a trend. Thus a key part of futuring is the managing of uncertainty and risk".[2] We see that a special part of probable futures, those possibilities that are of low-probability, or of simple plausibility but of high impact is differentiated and signified by a special term, they are represented by wild cards.

Clem Bezold's "Future cone" accounts in the same spirit for the usage of the term, too (cf. Bezold 2000; see Figure 10). As the "future cone" demonstrates, it involves wild cards that often fit within the "possible" band and occasionally within the "plausible" band. They may have a low degree of probability and so are considered as "worthy of consideration but unlikely" or "plausible at best". A wildcard may also have such a low degree of probability that they are considered "unlikely and not worthy of consideration" or "possible at best". We see that thinking is still unable to overcome the commitment to, the straitjacket of the probabilistic approach.

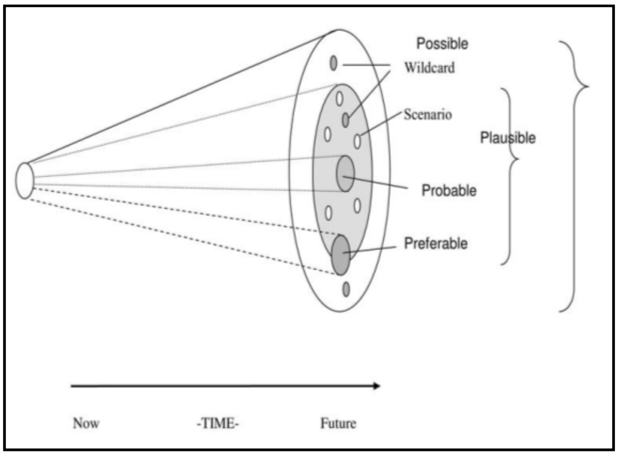


**Figure 10: Futures Cone**

Source: Bezold 2000

2 http://en.wikipedia.org/wiki/Futurology.

It is worthwhile to somewhat further explore how constructing wild cards is related to EIA in literature. In the last decade, constructing something called wild cards became an accepted technique for representing and assessing possible surprises. To construct wild cards is closely associated with EIA and perceiving weak signals. Wild cards help you indentify weak signals and identification of weak signals by EIA gets its sense in wild card construction. It is rather unlikely that a wild card does not include at least some hint on what sorts of weak signs indicate them, but this is not true in the reverse sense because weak signs may be identified on the existing background too as anomalous events.

When you construct wild cards you may not be able to identify more then "plausibility" or even only "possibility" without the ability to express the "plausibility" of the assumed "possibility". To be possible means that the issue expressed is still somehow consistent with your world view, with the very framing that makes issues an ordered set of events you are able and accept to recognize at all. But it is not at all clear how one can speak about some possibility without attributing plausibility to it. We will refer later to a technique to attribute possibility to issues even when they are not plausible in any sense but they become plausible through the effect of the applied technique.

How far can we say that the literature realises some consensus when speaking about what wild cards are and what is their relation to weak signals and how far is it essential to reconsider if more, different sorts of "uncertainty" should also be allowed than what we identify as an uncertain but plausible issue? In a couple of articles and in parts of two e-books, a researcher from the Finnish futurist school, recently at Nokia, Elena Hiltunen tried to understand how the terms wild cards and weak signals are used in the literature and how their usage and analysis has been making some progress. It may be no wonder that while surveying the definitions and examples in the literature she got the feeling that the field was rather messy. Different definitions exist parallel that emphasise different issues and, further, a lot of the exemplary cases do not fit either of the definitions. It is unnecessary to repeat that both wild cards and weak signals are essential for any futures scenarios methodology and that innumerable exemplary cases are included as being of practical importance in everyday life, economy, policy making and so on. The literature abounds in vindicated exemplary cases. But it is a small wonder also that on a closer look, as for example Hiltunen demonstrated, many of these cases fail to prove to be wild cards in any acceptable sense.

Concerning the definition of wild cards you find most of them referring to breakthrough of low probability and huge impact. This has been repeated, from 1992, perhaps with additional tags. Notice please that Hiltunen attacks the literature from the opposite side than we do. She wants, for example, to demonstrate that the alleged wild cards are mostly issues of gradual change, only. Further, she looks for a generally acceptable definition for wild cards while we try to show that the wild card term tries to cover a territory that resists a common definition, except a negative one. (Besides, we emphasise that even the most extreme wild card definitions are still captured by the possibility criterion.) In an important article, "Was it a wild card or just our blindness to Gradual Change?" (Hiltunen 2006), Elina J. Hiltunen discards the meaningfulness of the reference to low probability. Hiltunen draws attention to the market hit book "Out of the Blue: How to Anticipate Big Future Surprises" written by one of the world leading researchers in futures studies, John Petersen. He suggests that wild cards are "low-probability, high-impact events that happen quickly" and "have huge sweeping consequences" (Petersen 1999, p. 4). We find here the general inclination to attribute a probability characterisation to a wild card. So is it in the UN Millenium project, too. Special characteristic for being a wild card is the low probability of the issue. Just to refer to Alwin Toffler who was already, very early, committed to give a probabilistic interpretation to the future, was later, in the 80s, concentrating more attention to issues of low probability.

Hiltunen explains the inclination to probability based interpretation as follows: "The low probability characteristic of a wild card may have come into existence because scenarios have typically been divided, following Godet, into *possible scenarios* (everything that can be imaged), *realizable scenarios* (all that is possible, taking account of constraints) and *desirable scenarios* (which fall into the possible category, but which are not all necessarily realizable) (Godet 1993: 56)" (Hiltunen 2006, p. 66).[3] According to her, in this framework, low probability is a legitimate characteristic of a wild card. "However, there might be another view to the future: possible and realizable futures include all the futures, even those futures that are not imaginable and not constrained (i.e. 'normal') to us" (Hiltunen 2006, p. 66). In this conceptualisation the low probability of an event is not an essential characteristic of a wild card, in the meaning that "non-imaginable" events or issues may also belong to wild cards. Later, we shall follow this a little bit further.

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3 Hiltunen refers to Godet 1993.

In her opinion the common denominator in the literature is that wild cards are surprising events with significant consequences. In the mentioned article Hiltunen investigates the wild card problematique in two directions:

- What is the relation between wild cards, that are surprising and so impossible to anticipate, and gradual changes, gradual taken in the meaning of being not surprising, and so possible to anticipate?
- What is the relation between wild cards and weak signals (or as the latter are also termed differently, early warning signals /signs/, emerging issues)?

Besides setting these tasks Hiltunen tries to show that many of the exemplary cases in the literature do not prove to be really surprising if the receivers would have taken weak signals seriously enough.

It is worthwhile to make some more introductory remarks on the history of thinking on the wild card term. It is first to remark that speaking about wild cards is not new. As Hiltunen states: "although wild cards have become more prevalent in the literature during the last decade, they are not new. They are closely connected to other terms like discontinuities, or radical, or surprising changes and critical events." Ansoff talked about 'strategic surprise' in 1975, which he describes as 'sudden, urgent, unfamiliar changes in the firm's perspective which threaten either a major profit reversal or loss of a major opportunity (cf. Ansoff 1975, 22)'" (Hiltunen 2006, p. 62).[4] Notice please that with suddenness and surprise we touch on two new indicators or elements of what a wild card should point to! Concerning the surprise issues expressed by wild cards we face some imaginary sudden event, according to Hiltunen. This surprise is caused by some discontinuous process even when she narrows down the discontinuity to something represented by an S curve. On the other side we can hesitate and ask whether creeping catastrophes should be accounted for by wild cards. They are somehow not sudden processes, only perhaps at their end, but at least some of them may be characterised as plausible issues with high (catastrophic) impacts.

Let us turn to the "surprising" character of wild cards. When is something surprising? To be surprising belongs to the relation of observer and observed. Let us look at the observed side! Is the low probability of occurrence necessary or sufficient condition or neither of them? (Actually when something realises that has a low (but definite) probability only then there is nothing surprising in this.) Further, being something surprising refers only to the appearance of some new issue and/or to its consequences? Is something surprising, is it a wild card, if its appearance is not surprising but (here and then) it has very strong unexpected consequences, impacts as any technology assessment practice teaches about an important class of issues? Is the unexpected impact necessary or sufficient condition? What about the logical status of the combination of the surprising character of the frequency of the occurrence and of the impact?

Instead of concentrating on the surprising character another line in the literature concentrates on discontinuities as necessary (and/or sufficient) conditions when they speak about wild cards (cf., i.g., Notten et al. 2006). Instead of trying to put emphasis on the difference in terms of probability a wild card event has, as the majority accepts to speak about wild cards, for example, Philip W. F. van Notten, Am Sleegers and Marjolein B. A. van Asselt are for the essential differentiation between abrupt and gradual discontinuities (cf. Notten et al. 2006). In their interpretation we should keep the wild card term for abrupt discontinuities. The term somehow refers then to disruptive events, structural breaks, discontinuities, bifurcations and unprecedented developments as Sandro Mendonça, Miguel Pina e Cunha, Jari Kaivo-oja and Franck Ruff conclude from the overview of the literature. They define wild cards as "sudden and unique incidents that can constitute turning points in the evolution of a certain trend" (Mendonça et al. 2004, p. 201). They add to this that a wild card is assumed to be improbable, but it would have large and immediate consequences for organizational stakeholders if it were to take place. Mendonça, et al., see wild cards as "one of the most unpredictable and potentially damaging triggers of change of four conceivable components of change: trends, cycles, emerging issues, and wild cards" (Mendonça et al. 2004, p. 203). They differentiate between emerging issues and wild cards. But how should we look at EIA then? Are wild cards special sorts of emerging issues as it seems rational to accept?

So, we have a series of characteristics that could be used for definition, a series of different issues (!) even when we concentrate on the emergence side, only. Notice please that the consequences side is left out of focus, except that of the "huge impact", even when it can be surprising, not only huge, or quick or creeping, etc. Marcus Barber goes a step further in that direction and asks: "Will the wild cards have only minimal consequences within the framework of a given scenario or will it trigger an entirely new scenario? Such a

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[4] Hiltunen refers to Ansoff 1975.

differentiation between potent and less potent wild cards is possible only after completing the analysis of the consequences" (Barber 2006, p. 81). Emerging issues may be surprising or non-surprising, but they may not have huge impacts, but when they have they may be of quite different sorts according to different perspectives. The multitude of the possible phenomena to be subsumed under one term appears here too.

Our estimation is that researchers who try to define what should be ranged among the characteristics that define what a wild card is make a trivial mistake with that effort. They have the preconception that there is a well defined thing and they only have to uncover the necessary and sufficient characteristics to make the usage of the term referring to that thing unambiguously. Of course, because a term, i.e., wild card is introduced, in principle we can do it as we like it, provided we bound its usage so that it can be unambiguous. So we can prescribe that we use the term only for issues that we characterise say with low probability and high impact. But, the real task is quite different. We want to speak about all the different issues that can be found in a territory that is very first only defined by a simple negation: they do not belong to the normal issues, they are "wild". And obviously, different authors speak about a series of different types of events and processes. These types of events and processes may have a lot of overlappings according to different dimensions, in family resemblance relation without having a common essence. By mapping these relations we would have gotten a series of matrixes if we made a systematic effort in enumeration and characterisation of all the possible cases. Emerging issues can be sudden, unique, improbable, even implausible, or we refer to that case later, even "impossible", may constitute a turning point in some trend, may be most unpredictable and their effects can also be sudden, unique, huge, they can realise abrupt discontinuities or have surprising consequences. We could go further. According to John Petersen, there are three characteristics to define a wild card (cf. Petersen 1999). A wild card is something of low probability, high impact and happens quickly. Events/issues that fit this definition may be especially important. Hence we restrict the usage of the term that way. Those that fit the further narrowing down definitional efforts by adding the "surprising" character may further turn attention to something very important, from a special perspective, that of the observer.

We can choose the set of those issues that we intend to indicate by a special term. We can also choose so that issues to be wild cards events/issues exactly have to have these four characteristics. But as it may be seen from the outlined above the term "wild card" may perhaps be meaningfully kept for a wider class of events/issues, including also when only one, two or three characteristics are present. It depends on what we are interested in. Recently, we can not say that a clear understanding is easily provided for, at least as long as sticking to the wrong question is preserved and we ask what are the real (!) wild cards? Besides that, as Hiltunen warns us, in many cases in the literature claims may prove unjustified to speak about "wild cards", perhaps in any sense-making possibility indicated above.

We can see there is something recently that we suggest to be called "the wild cards jungle". One conclusion is then that it is advisable to move very carefully when considerations made by different authors are included in one and the same text just because they all speak about issues called "wild cards". They may speak about different aspects of the same issue but also about different issues. When we leave the simplicity of the already known issues we can be confronted with a confusing multiplicity of issues different from the known ones.

It may be evident from this sketchy argumentation that we cannot share the overarching assessment made by Hiltunen that "though there seems to be a mutual understanding of what a wild card is and what it is not, there is some fuzziness in this concept. This can be especially seen on the authors' listings of practical examples of wild cards" (Hiltunen 2006, p. 61). This evaluation profoundly downplays the jungle-like situation and, by trying to uncover what is the one that is really correct, the definitional work seems still to be in its infancy and on the wrong way, in spite of its crucial importance. As mentioned, attributing some further characteristic to the definition what a wild card "is", Hiltunen anchores at the suddenness of occurrence of a wild card issue as one further core element of the definition beside the low probability and high impact while others stick to being surprising too. But, obviously, with the wild card term we try to designate a very differentiated territory in which all sorts of non-usual "animals" exist.

We find that there are some features that can serve in conjunction to term a set of especially important issues/events. One feature is the discontinuity as abrupt change, the other is the surprising emergence of these events or issues, the third that they may be either of low possibility or even only plausible, we shall recognize later a further possibility, that of being "impossible" the fourth that the effects are huge. More precisely we should differentiate the same way among the effects too, according to their characteristics, such as sudden, "impossible", huge, surprising effects, etc. And then it should still be important to keep the spirit of the terminological differentiation to be able to account for creeping catastrophes too. Indicating special issues by special terms helps focus on something. We have different possibilities to choose and refer to by signifying one or more of them by one or more terms if needed. Terminology should mirror the importance of special cases in the practical experience of those who work with these issues or/and help theoretically analyse the research field.

Main stream "wild card" research may be characterised by the common belief that even "wild cards" should at least be "plausible" as we noticed already. We have just some place here to indicate a most important development in showing a dimension to which "wild card" thinking should be extended. Day and Schomaker reminded us of the importance of looking for non-usual unknowns. We have no more place here than just to indicate that it is most advisable to try to systematically take into account even the, "irrational", "unbelievable", "impossible" scenarios, too, breaking with the idea that the unusual issues worthwhile to take into account should at least be "possible" as something somehow "plausible" to be able to rationally account for them. Fortunately there is already some literature on the topic of imagining the "impossible", by giving a rational account of them. We refer to the articles of Theo Postma and Franz Liebl. They attack the narrowness of, the limit set for scenario building by the "plausibility" thinking to open ways to make conquests in the territory of unknowables.

## 4 On "Unbelievable", "Impossible" Scenarios

Kees van der Heijden divides future issues in three classes. There are predetermineds, uncertainties and unknowables (cf. Heijden 1996). We can call them type1, type2, type3 issues. Forcasting tries to account for predetermineds, either in a deterministic or a probabilistic way. Scenario building consciously tries to broaden the mental models dealing with uncertainties, i.e. when probabilities are unknown. Postma and Liebl point to some systemic drawbacks of, what they call the conventional scenario method (cf. Postma/Liebl 2005). They understand as conventional the method followed by the Shell tradition. Gill Ringland says that tradition is based on "the Pierre Wack Intuitive Logics" (Ringland 1998). This approach tries to frame the possible by setting a coherent and credible set of stories of the future. Putting scenarios side by side requires including extreme scenarios, but those that are still plausible – based on some ontological and methodological presumptions.

Exactly this coherence and credibility as limit is the subject of the critical assessment made by Postma and Liebl. As they observe first, "when we consider the current external environment of organizations, we can observe trends and countertrends, complex trends and trends or clusters of trends that had not been thought of beforehand" (Postma/Liebl 2005, p. 165). They observe further that the future fate of issues deeply depends on the different environments they get included. Their meanings, their impacts can even become extremely the opposite in different environments. Finally they observe that scenarios in real life are not necessarily coherent. Even more, you find innovative tendencies to produce some new by bringing incoherence in mixture of earlier coherent scenarios as it is often done by changing in the mode. These possibilities do not exist for the mainstream scenario approach, the systematic emergence of counter-trends in a coevolutionary way, the change of the meaning of some issue to its extreme opposite in changing contexts and the systematic production of incoherence. But were they unknowables beforehand? Could it be recognized that systematic overcoming the limits of the mainstream scenario building opens some further territory for systematic scenario construction work would be of the highest theoretical as well as practical importance.

Unknowables of Heijden are those issues where we not only do not know the probabilities but the outcomes either (cf. Heijden 1996). Efforts of Postma and Liebl concentrate on the task whether at least some part of these unknowables can be transformed into uncertainties (that means into issues that can be imagined as possibilities even when their occurence can not be characterised by probability). These issues can systematically be made contents of some recently still extraordinary, as they call "impossible" scenarios. What is at stake is to demonstrate that the conventional scenario approach can be overcome by epistemological(ontological and methodological) considerations on some very basic framing assumptions of the received approach that may be proven as limits that hinder that the scenario planner recognises and capitalises on some, recently extraordinary information possibilities. Postma and Liebl look for the effects of causal thinking that leads to the lack of looking for co-evolutionary developments, and lack of thinking in paradoxes.

What do Postma and Liebl demonstrate? The conventional scenario planning provides a set of scenarios side by side, each may report on different structures and causal chains. All of them are consistent in themselves. Stretching the possibility to its extreme the still plausible extreme scenarios, answering the "what if?" question will also be constructed as in themselves consistent scenarios but nothing more. Constructing scenarios is normally based on two principles. First, scenarios must be as imaginative as possible but must be based on the consistency and plausibility principle. Second, the way of scenario construction goes through identification of drivers. That means applying but not overcoming the search for causalities. "What happens to strategy formation", they ask, "if scenarios are not consistent and/or causality is infringed?" (Postma/Liebl 2005, p. 166). There is a main challenge to transform knowledge of Type 3 into knowledge of Type 2, to transform ignorance to uncertainty (cf. Postma/Liebl 2005, p. 167). The question is whether "impossibility" of something can not be at least partially reconsidered and revisited and if "inconsistency" and "implausibility" in sense of "unbelievability" or "impossibility" of some narratives should be kept as exclusion criterion for accepting some scenarios.

Postma and Liebl make the following considerations. First they turn to contextualisation. Then they find cases in the practice that trends often exist with countertrends together and they may mutually initiate and reinforce each other. They give place this way for some raising complexity. Recently in the mainstream scenario approach the limit to the imagination is that the imagined scenario can be "extreme but must be consistent". From where gets the consistency criterium its validity? – they ask. It seems that it is a logical criterion but it is not. It is a practical criterion only, it helps selecting the field to be looked for, they argue. Trends are conceptualised this way, each separately from the other. But this way, they recognize, "trends transgressing boundaries and contexts" are apriori systematically left out from considerations. This means practically that the scenario planning process stops when in the first circle the set of consistent scenarios is set and hence in the mainstream practice "new associations are likely to be neglected" (Postma/Liebl 2005, p. 167). You can get nearer to imagining "impossible scenarios" when the "what if?" question is changed for the "what has to happen to be realised it?" question. Starting from an issue without narrowing down the perspective, by setting the "what if?" question first, helps you to find factors and their combinations that would be overlooked otherwise, because of the methodological and ontological restriction in framing the search. It needs no further argumentation that this change in the methodology is most relevant for EIA and looking for what could be weak signals.

Base on the above said, it is the right place to repeatedly reconsider the definition possibilities of a wild card. Perhaps we should specially term those usually accepted wild cards, those scenarios that serve for some special methodological function, because they are able to move some unknowables into the set of uncertain issues, in a justified way. This functioning gives them their epistemological place and pragmatic importance. These wild cards represent a moving relation, on this interpretation. They would always represent some impossible scenario-construction possibility in any point of time in relation to the just normal or mainstream methodology, for example after accepting Postma's and Liebl's techniques as normal element of the methodology. They turn into some positive conceptualisation something that in the time of the conceptualisation, is by normal methodology forbidden or at least overlooked. Having recognized the way how to look for these historically bounded possibilities puts an end to their wild card status.

We make some more remarks on the terminology. The reader could recognize from the considerations above that special sort of "impossible" scenarios could be proved to be possible. They seemed only to be "impossible". If so, it is then perhaps more appropriate to call them "unbelievable" scenarios. The unbelievable – believable contrast seems better because it puts emphasis on the subjective side that these scenarios seem not possible to be constructed.

The considerations made by Postma and Liebl referred to above are among the most important methodological achievements in the last some years in futures studies, we believe. Perhaps Karlheinz Steinmüller also is in some respect in the transition path to the conception of Postma and Liebl (cf. Steinmüller 2003). He starts by referring to the definition set by the three institutes in 1992 (referred to at the beginning of this chapter) that is based on low probability of something being a wild card. "In a way, the definition of the three institutes plays down the real value of wild cards. Characterizing them by low probability and high impact misses a central point: The effect of a wild card is tremendous since it does not fit into our usual frame of reference, since it undermines our concept of the ordinary, normal way of things, since it makes the concepts doubtful according to which we regard the world. Wild cards change our frame of reference, our mental map of the world. This can be demonstrated by new words with new meanings after a wild card has happened: superterrorism, climate protection, or – to take some older ones – aids, stagflation, globalisation. Therefore, wild cards do not only change reality but also, and perhaps even more deeply, our perception of reality and our concepts. As it is often observed, they re-write the future, but they re-write also the past. We look with other eyes to past developments. Did they give rise to the wild card? Which trends were in favor of it? Which 'weak signals' already hinted at the wild card?" (Steinmüller 2003, p. 6).

Postma and Liebl published their view in 2005. Is there any reception story to identify? W. H. C. (Erik) Knol referred to them already in 2004. He refers with a summary to their article that was then still in manuscript form: "Scenarios are mainly focused on uncertainties of known elements to form causal and consistent combinations of projections. But Postma and Liebl (2005) argue that a projection of inconsistent, non-causal and unknown elements needs to be embedded in scenario methods in cases in which environmental turbulence is very high. In these cases it is important that scenario methods embed possibilities to focus on things we know we know, things we know we don't know and things we don't know we don't know. As a result, Postma and Liebl (2005) suggest that a scenario method alternatively based on so-called wild cards is useful, especially in case of assessments related to risks and opportunities of innovations. This additional approach not only introduces the standard 'what if ...' questions, but also focuses on unusual events triggered via 'what must happen, so that ...' questions" (Knol 2004, p. 616).

In a review of the scenario literature („Looking back on looking forward") prepared for the European Environment Agency in 2009 Robert Lempert (RAND Corporation), Michael Hallsworth, Stijn Hoorens and Tom Ling (all RAND Europe) describe concisely the experiences that recently motivate for developing radically new ways of thinking about the future. In the chapter on Treatment of surprise and discontinuities they say: "A reason often quoted for using scenario planning as a tool for futures analysis is its ability to reduce overconfidence about the future. However, a number of studies argue that it is difficult for scenarios to accommodate or anticipate surprises or discontinuities. The addendum to the Hart Rudman Commission (U.S. Commission, 1999), which warned of the dangers of a 911-scale terrorist attack, examined 20 scenario studies of U.S. national security and found that all tended to focus on extrapolations of current concerns and rarely focused on other possibilities that can produce startling emergent behaviour. Postma and Liebl (2005) suggest that standard scenario approaches tend to systematically exclude surprising or paradoxical developments as inconsistent or logical impossible. To overcome this limitation they suggested three different ways" (Lempert et al. 2009, p. 12). With this citation the very basic methodological achievement by Postma and Liebl is acknowledged. We have only to add to this assessment that on the base of integrating the achievement by Postma and Liebl new ideas are needed to felfedzni newer surprising possibilities.

Schoemaker and Day refered to Charles Darwin who had said: "It's not the strongest of the species who survive, nor the most intelligent, but the ones most responsive to change" (Day/Schoemaker 2006, p. 179). That behaviour can only be realised if we identify ourselves as existing in a world of endless transition and try to make anticipations that systematically overcome any approaches to the possible futures which are already solidified, including our last steps in opening what can be seen as wild card.

Last we have to make a trivial, but perhaps needed remark. Not all progress in repeatedly developing new types of "impossible" scenarios and any transformation the "unbelievable" into uncertain will save us from further "surprises". It may be even the opposite. In this respect systematically including recent techniques of construction of "impossible" scenarios represents a paradox progress. Some sorts of issues that would be "surprising news" cease to be surprising with this transformation. But the growing complexity with the social dynamic as well as processes of nature still unknown provide for new types of "impossible" scenarios because they systematically emerge at the shifting boundaries of action and cognition.

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# "It's All Coming Together Now …" – Converging Networks and the Network of Convergence

*Hans-Joachim Petsche*

## 1 The Myth of the Human Impact of Pure Technology

In the overview of the impressive report from the National Science Foundation and the Department of Commerce (cf. Roco/Bainbridge 2002a) entitled "Converging Technologies for Improving Human Performance", which gives an outlook 20 years into the future and includes contributions from more than 50 scientific leaders and policy makers (see Figure 11). Mihail C. Roco and William Sims Bainbridge trenchantly formulate the credo of the human impact of pure technology: "Moving forward […] could achieve a golden age that would be a turning point for human productivity and quality of life. Technological convergence could become the framework for human convergence" (Roco/Bainbridge 2002b, p. 6).

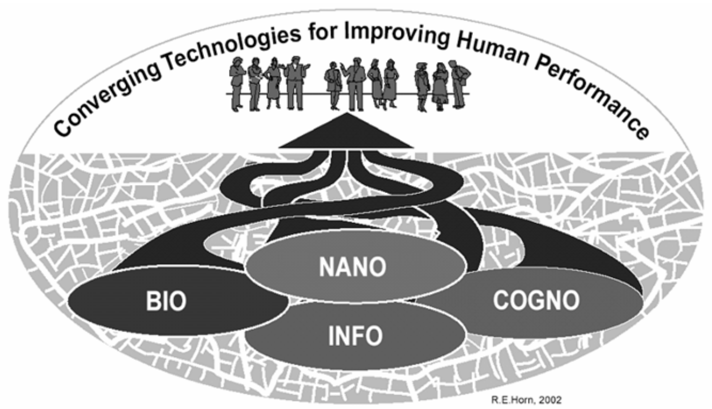



**Figure 11: Changing the Societal "Fabric" towards a New Structure**

Source: by R. E. Horn, in: Roco/Bainbridge 2002a, p. VII

Four years later, the crash of the internet economy is only 5 years back, we find the same emphasis in the Telstra White Paper "The Impact of Converging Technologies – It's All Coming Together Now". "Tomorrow is just around the corner", we read. "While the example above involves a degree of imagination there is no doubt that IT and communications is going in the direction we've outlined. Complete mobility is the name of the game and communications will become ever simpler to use, seamless, and ubiquitous. There will also be a blurring of the lines between work and private life in that many of the technologies and tools coming together in a convergent world will operate across both spectrums" (Telstra 2006).

Up to today, we have to notice – almost always and everywhere – the same game: the exaggeration, the myth and the disenchantment of the human impact of a pure technology. E-Learning, Knowledge Management and Computer Science will serve as examples here.

### 1.1 E-Learning

"The coming of the cyberclassroom may shake the education industry to its core and change almost everything we do in teaching economics" (Navarro 2000, p. 119), Peter Navarro put it in an article in the Journal of Economic Perspectives. And he opens his paper by quoting John Chambers, CEO of Cisco Systems, who wrote in the "New York Times" on 17 November 1999: "Education over the Internet is going to be so big it is going to make e-mail usage look like a rounding error".

In 2006, Marc J. Rosenberg retrospectively described the beginning of the E-learning wave: "With the advent of the Internet and the "e-enablement" of many business operations, such as customer care, sales support, e-commerce, supply chain management, and customer relationship management, investment and enthusiasm in e-learning exploded. Like every other industry in the Internet economy, e-learning company valuations went through the roof. The hype was on, fueled by industry experts whose books, speeches, and company Web sites proclaimed the revolution to be in full swing. There was nothing e-learning could not do. Consider this single well-meaning comment by Cisco Systems' CEO, John Chambers. Of all the pronouncements about the e-learning revolution, Chambers's remark was one of the most quoted and perhaps the most famous: "The biggest growth in the Internet, and the area that will prove to be one of the biggest agents of change, will be in e-learning" (Rosenberg 2006, pp. 12f.).

But already in winter 1999 we find some critical voices. Also reflecting the statement of John Chambers, Lawrence, E. Gladieux wrote under the headline "Global On-line Learning: Hope or Hype?": "Cisco Systems CEO John Chambers has identified education as 'the next big killer application for the Internet' (quoted in Thomas L. Friedman, 'Next It's E-ducation', New York Times, November 17, 1999). However, sorting out the hype from the reality in today's surging market for the electronic delivery of education is a challenge. The language used today to promote technology-delivered instruction – convenient, self-paced, individualized and interactive, faster and cheaper, flexible as to time and place – echoes that of a string of fads and movements in the United States throughout the 20th century. Thomas Edison speculated early in the century that motion pictures would replace textbooks as the principal medium of instruction. The radio revolution sparked a drive to hook up rural areas to state universities and allow course taking over airwaves. Forty years ago many heralded instructional television as the salvation of the American classroom. Video, satellite, and cable communications followed.

In each case technology enhanced and expanded learning opportunities for people who might not otherwise have had them. But history suggests that the impact of cutting-edge technologies consistently fell far short of the claims made by their proponents" (Gladieux 1999, p. 3).

The reality of E-learning shows the following picture. As early as 2002, after studying 139 companies in fifteen countries, DDI (Development Dimensions International) found that 75 percent of the respondents rated the effectiveness of e-learning as less than five on a ten-point scale (cf. Rosenberg 2006, p. 16). The burst of the dot-com bubble in the fall of 2001 also marked a turning point in e-learning. Marc J. Rosenberg pointed out nine myths which fueled the exaggerated promise of e-learning:

1. Everyone understands what E-learning is.
2. E-learning is easy.
3. E-learning technology equals e-learning strategy.
4. Success is getting e-learning to work.
5. E-learning will eliminate the classroom.
6. Only certain content can be taught online.
7. E-learning's value proposition is based on lowering the cost of training delivery.
8. If you build it, they will come.
9. The learners are the ones who really count (cf. Rosenberg 2006, pp. 18ff.).

As shown by Rolf-Rainer Lamprecht and Hans-Joachim Petsche, we should not believe in such myths. First of all, we need a new learning culture to make E-learning an efficient part of human education (cf. Lamprecht/Petsche 2007).

## 1.2 Success Story of Knowledge Management (KM)

The Second Conference on Professional KM took place in April 2003 in Luzern (Switzerland). It was the first and only workshop to date on Knowledge Management and Philosophy, organized by Klaus Freyberg (Munich Reinsurance), Bertin Klein (DFKI [German Research Center for Artificial Intelligence], Knowledge Management Department, Kaiserslautern) and the author (cf. Freyberg et al. 2003).

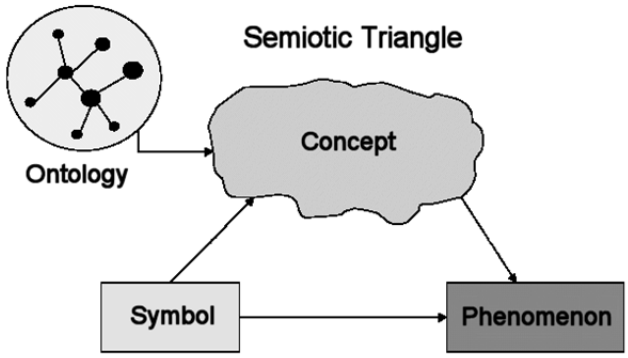



**Figure 12: Ontologies for Communication between Humans and Machines**

Source: Staab 2001; Unterstein 2001

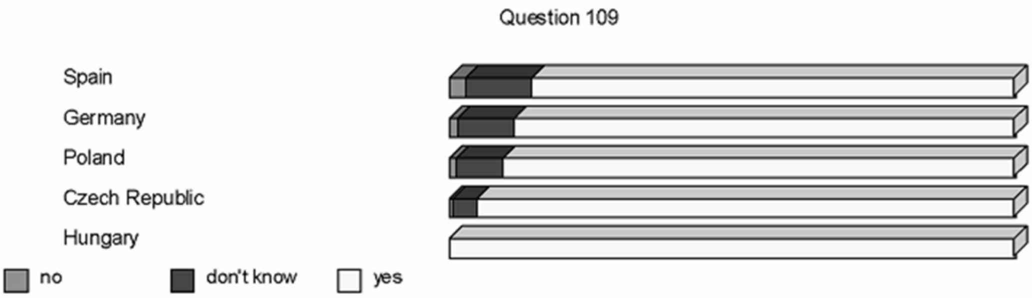
Reflecting the myth and the reality of computer-aided knowledge management (KM), there are two tendencies:

- On the one hand, KM has become an entrepreneurial activity and an established academic discipline. KM is enjoying a high profile and, to a large extent, shaping the image of the information society. "Ontology", a term taken from philosophy, has made major contributions to the progress of this discipline (see Figure 12).
- On the other hand, the success story of KM, however, must not be overestimated. In many respects the current KM views are still too limited. KM practices are often really just data management applications and there is a considerable gap between formal models and real-life processes. Fundamentals of KM are still lacking, as is a theoretical framework for the overall process.

Often we find the opinion that the Internet is today's most important knowledge medium and therefore the kernel of the knowledge society. If we take a look at the 2005 CULTMEDIA-Survey of students from Germany, Hungary, Poland, Spain and the Czech Republic (cf. Petsche et al. 2007a, 2007b), we will see that this is also a mythical representation of a more complicated reality.

If we ask students why they use the Internet, offering them the statement "One obtains information and news", we get the following answers (see Table 18):

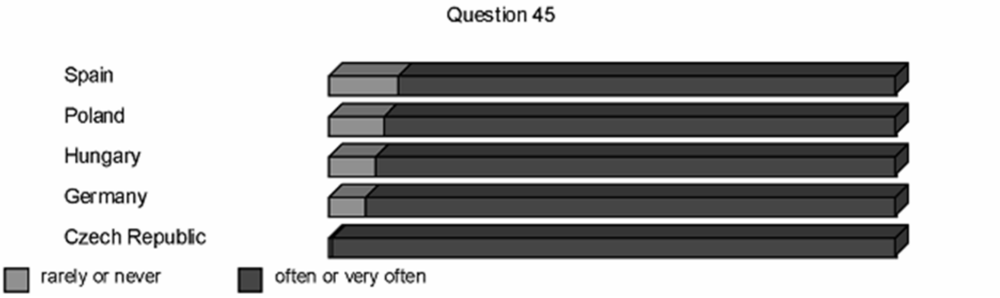
**Table 18: Students' Evaluation of the Statement that obtaining Information and News is a major motive for Internet use**




Source: Petsche et al. 2007a, 2007b

With some critical remarks and a glimmer of disbelief from the students from Spain and Germany, we find that almost all students are willing to use the Internet to obtain information and news. As shown in Table 19, most students often or very often search for information on the Internet in everyday life.

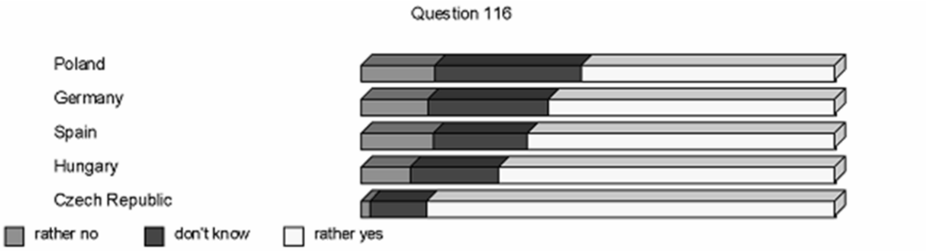
**Table 19: Students' Evaluation of the Statement that they often look for Information on the Internet**




Source: Petsche et al. 2007a, 2007b

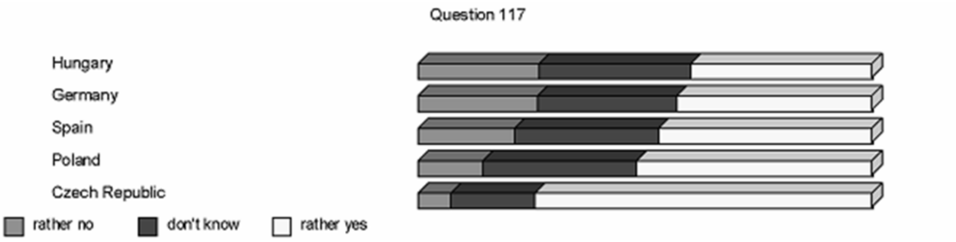
It seems that the Internet is a very important medium concerning information and knowledge for all students. But if we ask about the quality of the information, we get a different picture (see Table 20 – 22).

**Table 20: Students' Evaluation of the Statement that the Internet is a Perfect Medium for Getting Questions Answered**



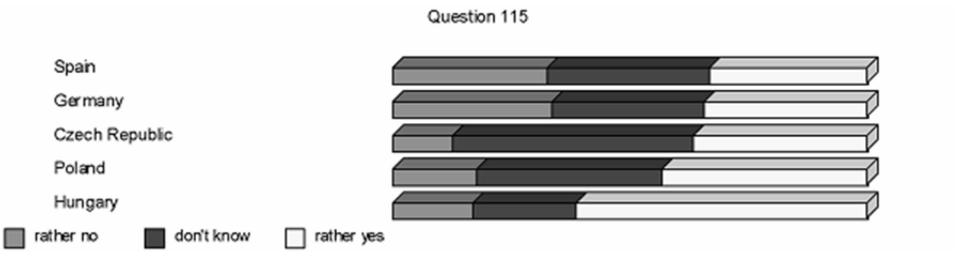

Source: Petsche et al. 2007a, 2007b

**Table 21: Students' Evaluation of the Statement that the Probability of a Sufficient Answer is Higher on the Internet than in Any Other Medium**




Source: Petsche et al. 2007a, 2007b

**Table 22: Students' Evaluation of the Statement that One Avoids Errors by Asking Specifically for Information**




Source: Petsche et al. 2007a, 2007b

We find, all in all, that trust in the quality of the information obtained via the Internet is very low. The expectation that better questions will lead to better information is even lower. Therefore we may conclude that:

- The Internet is substantially used for goal-directed information search. Information search is an important motive for internet usage.

- Although that the Internet is regarded as an ideal knowledge medium, there are large national differences with respect to the valuation of the quality of the knowledge it offers.
- The use of Internet as an information and knowledge medium is a cultural practice. It is also determined by culture and not independent of the cultural context (nationality and language).
- There is no context-free knowledge management that is independent of everyday life.

### 1.3 The Hype, the Myth and the Disenchantment of Computer Science (CS)

There is no doubt that computer science is one of the most important sciences today. It is developing rapidly. Computer scientists have great opportunities. There seems to be no myth, just a permanent hype…

But at this very moment the "Death of Computing Debate" has started in Great Britain.[1] Neil McBride, director of the Centre for IT Service Management Research at De Montfort University in Leicester, provocatively portrayed the situation in an open letter to the UKAIS[2] 2007 Conference, published online: "There is a possibility of computing going the way of the textile industry and possibly even faster because the start-up costs are lower for software development than textiles. My worry is not that lots of the basic programming work is done in India, […] it's that Indian IT companies and universities are giving large amounts of investment and staff time to think up new ideas".[3]

Continuing his analysis, McBride comes to the conclusion: "I think that a major part of the problem is cultural. The stereotypical portrayal of computer experts as geeks has an underlying truth. That engineering unawareness of how people feel, that social awkwardness, is a characteristic of people, many in computing including me. I am merely a contained, reined in computer geek who has buried the programming manuals".[4]

"There is no doubt that computing is in crisis" (McBride 2007, p. 7). As indicators one might consider:[5]

- The number of US students choosing computer science has dropped by 39 per cent between 2000 and 2005.
- Algorithms, operating systems, data and program structures are a scene that has remained unchanged for 30 years.
- Computer science is an out-of-touch, dying discipline. It must embrace interdisciplinary views in order to survive.

The fact that computer-science academics have lost touch with the real world is – according to McBride – the main problem:

- "*First*, they have failed to engage with society, to properly acknowledge the social embedding of computing and its changing role.
- *Second*, they have not put sufficient effort into searching for new paradigms. Like physicists at the start of the 20th century, they are not thinking outside the box.
- *Third*, they have failed to engage with industry" (McBride 2007, p. 7).

In other words, we can sum up the ups and downs of e-Learning, Knowledge Management and Computer Science by asking if there is a new hype or – perhaps – a new hope in the development of the Internet.

## 2 Will Web 2.0 be to the Rescue?

According to the founder of the World Wide Web and director of the World Wide Web Consortium, Tim Berners-Lee, Web 2.0 will not even be a hype, but only piece of jargon. In his view, Web 2.0 is in no sense a new development. In a podcast on the IBM developerworks site, he remarked in July 2006: "Web 1.0 was

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1 The main debate was started in February 2007 by Neil McBride with the headline "Erase old programme and launch new version" (McBride 2007).
2 UKAIS = United Kingdom Academy for Information Systems.
3 URL: http://www.cse.dmu.ac.uk/~nkm/PAPERS/Dear Professors.pdf [March 2008].
4 URL: http://www.cse.dmu.ac.uk/~nkm/PAPERS/Dear Professors.pdf [March 2008].
5 Cf. N. McBride: The death of computing (Member view – 22.01.2007). Future of computing home of the British Computer Society. – URL: http://www.bcs.org/server.php?show=conWebDoc.9662 [March 2008].

all about connecting people. It was an interactive space, and I think Web 2.0 is of course a piece of jargon, nobody even knows what it means".[6]

The comparison of some of the traditional applications of the WWW with the corresponding ones of the so-called Web 2.0 shows that the remarks of Berners-Lee do not get the gist of the changes (see Table 23).

**Table 23: Comparison of Web 1.0 and Web 2.0 by Prototypical Example**

| **Web 1.0** | **Web 2.0** |
|---|---|
| - mp3.com | - Napster |
| - Britannica Online | - Wikipedia |
| - Personal websites | - Blogging |
| - Directories (taxonomy) | - Tags ("folksonomy") |
| - Content management | - Wikis |
| - Publishing | - Participation |

Author's archives

Without any major technical changes, a distinctive form of interaction between the users is manifest. Not the technical inventions are in the foreground, but the interactive social embedding becomes more important. In this sense, Web 2.0 is a "bird of paradise" and not a "robot" from a high-tech lab (see Figure 13).

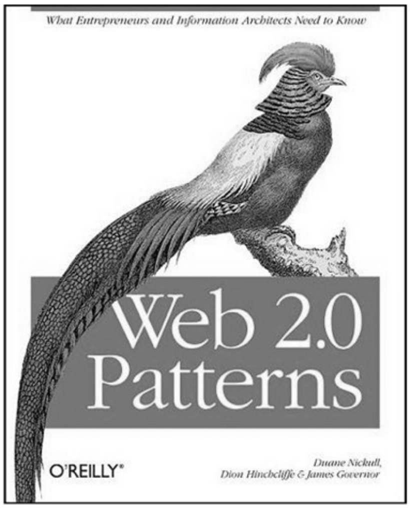


**Figure 13: First draft of the cover of the Book *Web 2.0 Patterns: What entrepreneurs and information architects need to know*, written by Duane Nickull, Dion Hinchcliffe, and James Governor (published in Cambridge 2009)**

Statements from some other Internet pioneers also head in this direction:

- "What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software" (Tim O'Reilly, September 2005).[7]
- "Web 2.0 is the network as platform, spanning all connected devices, an ecosystem for communicating, connecting, collaborating and creatively expressing ideas and information in revolutionary new ways" (Duane Nickull, March 2007).[8]

6 Cf. developerworks interviews: Tim Berners-Lee, Originator of the Web and director of the World Wide Web Consortium talks about where we've come, and about the challenges and opportunities ahead. Recorded 7-28-2006. – URL: http://www-128.ibm.com/developerworks/podcast/dwi/cm-int082206.txt [March 2008].

7 Tim O'Reily: What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. Published on O'Reilly (http://www.oreilly.com/), 30.09.2005. – URL: http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html [March 2008].

- "Web 2.0 and SOA (Service-oriented architecture) are 'two sides of the same coin […] THE biggest thing happening in corporate computing right now is called SOA – service-oriented architecture" (Graeme Philipson, July 2007).[9]

It is clearly recognizable that this "ecosystem for communicating, connecting and collaborating" – which is how Duane Nickull characterizes Web 2.0 – leads to a paradigm shift in the development of Internet technologies.

It is not a question of *developing system architectures* in as perfect a way as possible. In the first place, it is a question of *deploying services* which are able to serve the needs and requirements of people in complex situations.

It is a shift from the system to the service perspective. This paradigm shift emerges particularly clearly in a 2008 paper of Lars Mathiassen and Carsten Sørensen, in which they juxtapose the system and the service approach (see Table 24).

**Table 24: Differences between Systems and Services Perspective of Organizational Information – Shift from Structure and Function to Interaction**

| Systems | Services |
|---|---|
| IT artefact focus | Use of IT focus |
| Generic support of complex tasks | Response to specific requirements |
| Homogeneous packages of capabilities<br><br>Integrated with other systems | Heterogeneous portfolios of capabilities<br><br>Instantiated with other services |

Source: Mathiassen/Sørensen 2008

With the paradigmatic change of perspective, developed as a business concept and often labelled "social networking", a new kind of cultural space is opening up. The new cultural weight of Internet technologies is reflected in a higher impact of design aspects. The mediality of the Internet must therefore be seen as shown in Table 25.

8 Duane Nickull: Web 2020:Architecture, Models and Patterns for the New Internet. Slides by Duane Nickull, Sr. Technology Evangelist, Adobe Systems, inc., Etech March 2007. – URL: http://www.slideshare.net/tvawler/web-20-2-architecture-patterns-and-models-for-the-new-internet [March 2008].

9 Graeme Philipson: Web 2.0 and SOA are 'two sides of the same coin'. Fairfax Digital Network, 31.07.2007. – URL: http://www.theage.com.au/news/perspectives/web-20-and-soa-are-two-sides-of-the-same-coin/2007/07/30/1185647825516.html [March 2008].

**Table 25: Mediality of the Internet**

| **Mediality of the Internet**<br>**Internet as Intermediation** |
|---|
| = |
| **Unity of Means, Medium and Environment** |
| |
| • as ***means*** it is technological |
| • as ***medium*** it belongs to the sphere of communication |
| • as ***environment*** it is structuring cultural spaces |
| |
| **Perspectives of the Internet** |
| • ***instrumental*** perspective |
| • ***communicative*** perspective |
| • ***cultural*** perspective |
| |
| **Design Aspects of the Internets** |
| • as a ***structure*** of a system |
| • as a ***function*** of a service |
| • as ***interaction*** in a socio-technological space |

Source: Petsche 2005, 2007

If we represent Table 25 as a Rubik's Cube (see Figure 14), the social shift of the Internet becomes visible as an upward arrow. It points from the bottom – the instrumental use of well-structured means – to the top: The cultural environment of interaction.

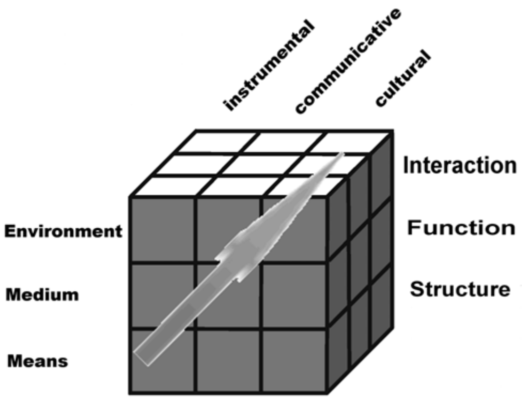


**Figure 14: Rubik's Cube of the Cultural Shift in Internet Mediality**

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If we follow the paradigm shift from the system to the service view, we will get higher functionality and more interaction, but also more equivocation and uncertainty (this relationship is discussed in detail by Mathiassen/Sørensen 2008). Some interconnections are shown in Table 26.

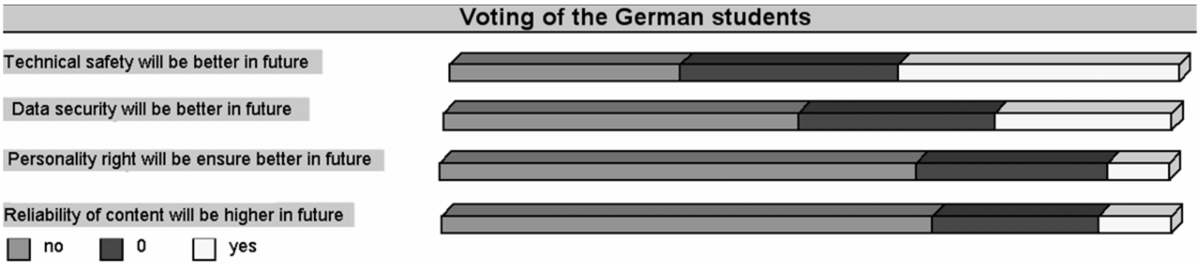
**Table 26: Service Levels in the Field of Equivocation and Uncertainty**

| | | **Uncertainty**<br>**Low** | **Uncertainty**<br>**High** |
|---|---|---|---|
| **Equivocality** | **High** | *Adaptive service*<br>Use of information<br>Relationship service. Standardized Information | *Collaborative service*<br>Production of information<br>Relationship service. Standardized Material |
| **Equivocality** | **Low** | ***Computational service***<br>**Use** of information<br>**Encounter** service. Standardized **Process** | ***Networking service***<br>**Production** of information<br>**Encounter** service. Standardized **Connection** |
| | | ***Need-to-do-something*** | ***Need-to-know-something*** |

Source: Mathiassen/Sørensen 2008

This shift in internet risk from a technical to a cultural dimension is already felt by the users. A look at the 2005 CULTMEDIA-Survey shows us that, for the German students, the human, not the technical aspects of the Internet bear the highest risk in the future (see Table 27).

**Table 27: Evaluation of the Development of Internet Risks by German Students**




Source: Petsche et al. 2007a

If we distinguish tree fundamental aspects of a malfunctioning of the Internet (cf. Petsche 2007d):

- security (linked to information),
- safety (linked to technology), and
- reliability (linked to culture),

we can establish another Rubik's Cube that shows the shift in Internet risks (see Figure 15).

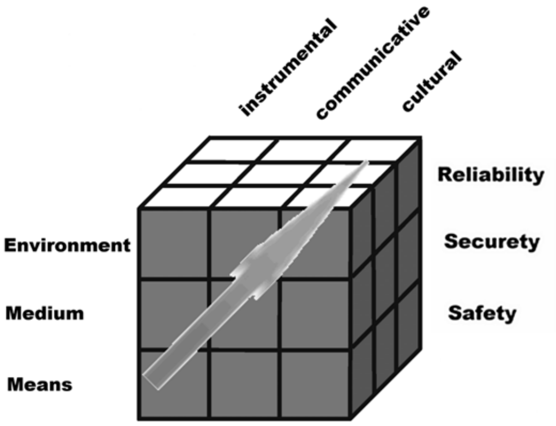



**Figure 15: Rubik's Cube of the Cultural Shift in Internet Risks**
Author's archive

Now, the arrow points from the bottom – the safeness of instrumental use of means – to the top: The reliability of the cultural environment.

Summing up, we find that in the shadow of a relatively meaningless label such as "Web 2.0", a reorientation of computer science and a restructuring of organizational studies has begun. It is here that we find indicators of a "cultural turn" in the technological conception and everyday use of the Internet. The interface design aspects become increasingly important. We find a significant shift from the structural view of medial systems to the functional view of mediated services and the organisation of interaction in socio-technological spaces. In this context we observe a growth in new, culturally conditioned risks for personal rights and personal freedom.

# 3 What Can We Do to Minimize the Risks?

The most important question at this point is how to handle risks. According to Imre Hronszky and Ágnes Fésüs we have to learn to deal with the limitations of our rationality because the nonlinear character of complex systems prohibits deterministic claims to power (cf. Hronszky/Fésüs 2006). Preventing risk (which is – by the way – impossible in many cases) focusing on the management of risk is insufficient. It seems more important to develop cultural strategies which follow the Heideggerian concept of "Sorge" (care and concern) and lead to a value-driven approach to life (see Figure 16). Such a "principle makes it clear that decisions and developments in science and technology are based first of all on values and only secondarily on scientific and technological fact and process. Moreover, a precautionary approach is best carried out in the context of goals that embody the values of communities and societies" (Myers 2002, p. 210). The cultural shift in Internet development makes risks more and more a problem of democracy, instead of technology.

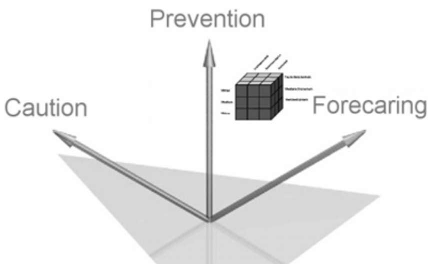



**Figure 16: Strategies for Value-Driven Reduction of Internet Risks**
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We find a philosophical approach to a non-technical concept of reason that can create theoretical legitimacy for human concepts of reason and risk management in Alfred North Whitehead. In his book "The Function of Reason", written in 1929, we discover the crucial points of Whitehead's philosophy for a new era of social interaction. The most important points are:

1. The inner unity of everyday and scientific experience must be defended.
2. The world is not simple, but complicated.
3. The world is not composed of things but of processes.
4. The subject-object structure of language blocks our view of reality as process.
5. Valuations are intrinsic aspects of all processes.
6. "The function of reason is to promote the art of life" (Whitehead 1958, p. 4).
7. Vision cannot replace utopia.

By rebuilding the world in care and concern for life, we recur to vision as well as utopia. The former are projections from the present into the future, the latter are projections from the future into the present. The former are technical interpolations, the latter blurred pictures of expectations and hopes (see Figure 17).

In this sense, converging technologies will only serve to improve human achievement if they are directed by the main duty of reason: the "the art of life".

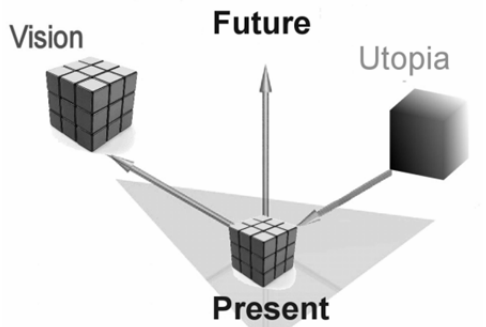


**Figure 17: Relations between Vision and Utopia**
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# Ethics of a Science and Technology-based Development in Mexico and Latin America

*Medardo Tapia Uribe*

## 1 Introduction

More than one year ago, I submitted a research project to examine the possibility of making a region's scientific and technology resources the foundation of its development. Specialists like Michael Porter and Henry Etzkowitz maintain that a partnership between businessmen, scientists and government can make this possible. It is known as the triple helix theory.

We interviewed 91 of the most distinguished researchers in their fields; 14 of them were in charge of directing their research institutes, while several of them are nationally and internationally awardees. We also interviewed 31 businessmen, all of them top executives. In addition we interviewed 13 government officers, most of them state government secretaries or undersecretaries, and five directors of technology based business *incubators*. We conducted at least two kinds of interviews (open ended interviews, and expert's panel workshop) and ran a Delphi survey. Among different document resources, we made several analyses on 1990, 2000 Mexico's census, 2004 Economic census, Mexican National Economic Accounts of several years, 2001 Agriculture National, as well as several Morelos State governor's annual reports. We must also emphasize that part of the research report's purpose was to appeal to government and business decision makers, as well as to encourage researchers to ally themselves. Accordingly, we designed a research project that would produce a public policy framework, as well as an appeal to thinking about a different kind of development future for this Mexican region in terms of alternative scenarios of development. Prospective scenarios are a specialized planning tool that have no predictive character; their validity rest upon its plausibility as well as being attractive to those who make decisions.

We must specify that a scenario is a narrative that connects a description of a specific future to current realities by mean of a series of causal linkages that illustrate decisions and consequences (cf. Glenn/The Future Groups International 2005). Non industrialized countries and their regions have the possibility of advancing more rapidly in this process if they base their strategies in the construction of "knowledge niches". They should be able to skip certain stages of development and to implement certain strategies to attract foreign investment and technology transfer (cf. Etzkowitz 2003). The developing of future scenarios is part of a strategy of planning processes. The most useful scenarios are those that present the condition of development variables at different moments: a narrative of the evolution of those conditions and those variables by means of describing certain important and determinant events.

The building of a possible future alternative scenario required us to analyze first tendencies; then create an inventory of scientific and technology resources, identifying those that are potentially the most productive and competitive ones as well as critical for the Morelos region; and, finally, presenting two kinds of scenarios: the *inertial* scenario, the most likely scenario according to the dominant tendencies, and a mixture of a desirable and possible alternative future scenarios. This is what we present here.

The inertial and alternative future scenarios we propose arise parallel to another pair of concepts, governance and new public management, both of which tried to respond to a series of development problems, especially dramatic in developing and underdeveloped countries. These proposals were some way related to the recommendations of those policies known as The Washington Consensus (cf. Fine et al. 2001) – policies that prevailed during much of the 1980s and 1990s.

The Washington Consensus held that good economic performance required liberalized trade, macroeconomic stability and getting prices right… Once the government handled these issues – essentially once the government "got out of the way" – private markets would produce efficient allocation and growth (cf. Fine 2001a). It was also expected, however, that poverty and inequity would decrease. By the middle 1990s there was widespread dissatisfaction with development results of the Washington Consensus policies. In Latin America, since 1990 a group of Latin American and Caribbean government officers have gathered at a conference held at the International Institute of Economy in Washington. The conference's purpose is to evaluate their development achievements after the 1980s debt crisis. Income distributions have not bettered and in some countries have gotten worse; poverty indexes have remained basically the same, and middle class employment and income has become unstable. They all agree, basically, that further changes are necessary, and that Washington has ignored the function that institutional “changes” could play in accelerating social and economic region’s development (cf. Burki/Perry 1998). It was the time of institutional reform.

Institutions, it is important to remember, are those sets of norms that shape organizations and individuals’ behavior within a society. Such norms can be formal, like constitutions, laws, rules, and organizational procedures; or they can be informal, like values or other kinds of social norms (cf. Burki/Perry 1998, p. 2). World Bank specialists sustain that Institutional reforms were a demand of different sectors of society because of economic globalization, Latin American countries’ democratization processes, and the first generation of Washington Consensus policies.

Part of those institutional reforms imply new kinds of financial institutions and systems that could grant more stability; better public services, education quality and a more efficacious judicial system that contribute to increase the productive sector competitiveness. Latin America democratization processes, in addition to this, also demand government decentralization to local authorities, efficacious and efficient results, accountability mechanisms and, in general, a new public management.

Nevertheless, neither civil society nor the productive sector are coordinated enough to carry out public action, to contribute to institutional reforms, and to face Latin America development problems. In addition to the traditional political representation that has come into crisis, due to the unfulfilled perennial equity and development promises, university research contributions, as Etzkowitz proposed, demand a new institutional design as well.

It is also clear that new alliances between different sectors of society and new forms of organization are necessary. Some of these alliances are not new. Others have been resistant to being successfully linked in México and Latin America. Such is the case of small and large business firms, as well as the university and the productive sector alliances. This is why, rather than promote these alliances from outside or being imposed by a certain kind of central power or government, the construction of such alliances must rest upon a dialogic democratic ethos as well as such new institutions – rules, laws, norms and values – to face and take decisions over our almost perennial Latin American development, poverty, equity, and sustainability problems. Some specialists have synthesized these alliances as social capital, the social and political dimensions of development. Social capital may be the ideal complement to the economic analysis of post – Washington consensus; this is precisely what is missing from neoclassic economics and is being made part of what is now known as endogenous or new growth theory.

The challenge for development theorists and policy makers alike is to identify the mechanisms that will create, nurture, and sustain the types and combinations of social relationships conducive to building dynamic participatory societies, sustainable, equitable economies, and accountable developmental states (cf. Fine 2001b).

The latest definitions of social capital, different from those offered many years ago by Pierre Bourdieu, James S. Coleman and Gary Becker (cf. Bourdieu 1991), and closer to Robert D. Putnam’s (cf. Putnam 2003) – social networks and associated reciprocial norms –, include several areas of application from economic development, to community life, work organization, democracy and governance, and collective action. The World Bank defines it as “the internal social and cultural coherence of society, the norms and values that govern interactions among people and the institutions in which they are embedded” (Fine 2001b, p. 138). Social capital is, then, a useful strategy and mechanism of public action – the collective construction and qualification of societal problems, delegated or not delegated to the government, as well as the actions, instruments and processes to confront them – (cf. Cabrero 2005). Social networks, as social capital or as public action, is one of the most advanced forms of social organization (cf. Villanueva 2006) to confront public problems.

In addition, this paper proposes to conceptualize local development problems as a debate, as Alain Touraine proposes it, and furthermore as an argumentation – to bring into a dialogue those interests worthy of becoming universal, the real foundation of the moral world –. Touraine sustains that the real engine of change of society is ethics, because it is society’s capacity to reflect on itself, and to perceive its own action capacity (not as it is currently, but as it is oriented to change, as society should be) (cf. Touraine 1995). The parameters we will be using for this purpose are those proposed by Adela Cortina (cf. Cortina/Martínez 2001).

1. Dialogue is the only reasonable way (of moral education) because there are no compulsory material ethical principles for all, and indoctrination is against human rationality.
2. Ethical principles are of procedures, meaning that they only indicate the norms for discussion, for those concerned over the rightness of a certain norm.
3. Those concerned with a certain decision must have participated in the debate in conditions of rationality, that is, after a dialogue celebrated in conditions of symmetry, and whose results are a product of the force of the best argument rather than any other kind of coercion.
4. Decision over the rightness of norms is always subject to review.
5. There is a dialogic ethos behind every moral decision:
   - To express my position over an issue I know of the needs, interests and arguments of all of those concerned by a norm.
   - We must gather as much information as possible by means of dialogue and inquiry.
   - All participants in a dialogue must be willing to disclose their interests and needs to all concerned, and offer their argument's proposals.
   - There is good will toward satisfying interests worthy of becoming universal.
   - He/she is willing to assume the consequences of his/her decision.
6. The rightness of a dialogical ethics does not rest upon any kind of agreement that is reached by group consensus or by majority decision. The rightness of a norm is an issue to be solved by a person, who decides the obligatory character of any norm as long as he is willing to listen, reply, and decide based on satisfying interests worthy of becoming universal.

Before proceeding to the analysis of empirical data and research results, allow me to put the accent on one last thing, the value of the product or service about which the government, the region or the alliance are trying to be competitive or equitable, or to make our world sustainable for future generations. It is known as the public value of the services a government provides. As I said above, getting better results – being more efficient and efficacious than in the past with respect to indexes of development and poverty and equity – requires having as a parameter the public value of such product and services, that is, the value that this represents for society. This means that achieving an international or national competitive productive sector without social efficacy means low public value.

## 2 The Regional Case in the Mexican and Latin American Context

Mexico is ranked last among OECD countries in terms of its R&D investment percentage, and almost all of its research is publicly funded by the Mexican government. In addition, Mexico is ranked among the last three countries with the lowest level of competitiveness out of 49 countries, according to the "World Competitiveness Yearbook" with respect to business technology cooperation, interest in science and technology, financing of technology development, and the relationship between basic research and long-term economic development (cf. FCCyT 2004, p. 190).

This challenge was addressed by the Scientific and Technology Consulting Forum (Foro Consultivo Cientifico y Tecnologico; cf. FCCyT 2004, p. 11), a collegiate body of researchers negotiated before the Mexican Congress and established by the 2002 Mexican Science and Technology Law. FCC&T advises Congress and the Office of the Mexican President on science and technology, and is different from the Mexican Ministry of Science and Technology.

While East Asia grew at an average of 6.5% during the 1990s and reduced poverty by 15%, Latin America and the Caribbean (LAC) grew at a discontinuous average of 1.5% and poverty increased (cf. PNUD 2007). LAC average rate of growth between 1980 and 2005 was 1%, a fifth of East Asia's. In 1950, LAC's average per capita product was 30% that of the United States; nowadays it is only a fifth of that. This is one of the reasons Mexico is ranked 47th among 55 countries in the 2007 World Competitiveness Yearbook, two positions lower than in 2006; below Chile (26), Colombia (38) and above Brazil (49), Argentina (51) and Venezuela (55). These indexes are a result of applying 312 indicators that could be grouped in four factors: economy management, government efficacy, business efficiency, and basic infrastructure and technology infrastructure. The World Economic Forum's Growth Competitiveness Index summarizes three indexes: technology, public institutions and macroeconomic environment. Finally, another example of how to measure the factors that drive competitiveness is OECD's indexes. OECD identifies four aspects: creation and dissemination of knowledge, innovation and development, advances in information and communications technologies, degree of globalization and productivity and economic structure.

In 2003 Mexico developed its own competitiveness index, the International Competitiveness Index (cf. IMCO 2006). They chose ten factors as determinants of a country's competitiveness:

- a reliable and objective legal system;
- sustainable management of the environment;
- a healthy, prepared and inclusive society;
- a stable macroeconomy;
- a functional and stable political system;
- efficient markets;
- world class leadership sectors;
- efficacious and efficient governments;
- good international relations;
- most promising and potential economic sectors.

They used international agencies' databases to determine Mexico's international competitiveness index. The 2005 results were not very different from other Mexican competitiveness evaluations. In this evaluation, Mexico ranked 31st among 45 countries. Ireland was first, followed by Finland, Australia, Sweden, United States and Denmark. Among those countries that have a similar per capita GDP, Hungary, Czech Republic, Chile and Brazil ranked above Mexico. Mexico, in contrast, is above Turkey, Colombia, Costa Rica and Venezuela. In 2006 Mexico ranked 33. Colombia ranked above Mexico. Hungary was 22.

The Mexican competitiveness analysis also evaluated Mexican states' competitiveness. This is useful in our analysis because Mexico and Latin America have lacked democratic processes at different levels of government, and this has an impact on governments' efficacy in facing development problems. A Mexican specialist has said that, independently of the stage we are at in our democratic transition, we still live democracy more as a doctrine than as a form of government (cf. Villanueva 2006). Decentralization is not only a demand of local governments in Latin America against a history of centralized and mostly authoritarian and ineffective governments; it is also a demand for locally confronting development problems, and adding the difference, the particular of their own history and cultural identity. Finally, decentralization and democratization mean addressing their own resources and their own development problems, instead of simply reproducing the structural world wide and national accumulation models (generally presented as a universal development model or paradigm), and simply performing the "specialized" functional role that is assigned (cf. Arocena 1995). This is why it is important to look at Mexican local or state competitiveness indexes. We will do this by focusing on the social aspects, even though we will be referring to some of the economic ones that we mentioned above. We will also be presenting some of the empirical data we gathered with our own research. At the end we will be offering some of the alternative future scenarios of development we constructed for the Mexican region we studied.

Among the Mexican states ranked at the highest level of competitiveness – Distrito Federal, Aguascalientes, Nuevo León Baja California Sur, Baja California – three are in the northern part of Mexico, one in the north west, and one is Mexico's capital. Chiapas, Oaxaca, Guerrero, San Luis Potosí, Hidalgo and Tabasco are ranked at the lowest level of competitiveness. Morelos, our case study, is ranked in the middle. There is no pattern that identifies Mexico's leading states in competitiveness.

Mexico City, for example, is ranked first because of the following factors: Healthy, prepared and inclusive society, a stable macro economy, world class leader sectors, most promising and economic sectors. Baja California, on the border with the United States, is ranked second mainly because of its good international relations, prepared and inclusive society, and a reliable legal system, Nuevo Leon, ranked fourth, owes its position to its reliable legal system, and world class leadership sectors.

Those Mexican states ranked at the lowest level of competitiveness have low economic indexes and have no clear pattern of other competitiveness factors. Chiapas, for example, has the lowest competitiveness indexes for "Healthy, prepared and inclusive society", a stable macro economy, a functional and stable political system, most promising economic sectors, and world class leader sectors.

Oaxaca, also in the southern part of Mexico, like Chiapas ranks very low in the two economic competitiveness factors as well as Healthy, prepared and inclusive society and Good International Relations. Surprisingly, the best competitiveness index is a Functional and Stable Political System. This in spite of Oaxaca has lived in the last couple of years a very unstable political situation. In contrast Guerrero state ranks this political factor as its lowest level of competitiveness. In sum, all these indexes do not seem to be that reliable as measures of competitiveness.

Morelos, our case studied in depth, has as the lowest competitiveness index Most Promising Economic Sectors, Efficacious and Efficient Government and Good International Relations. Morelos' best competitiveness index is A Sustainable Management of the Environment. This is a surprise given that, as we will see below, Morelos has lost a good percentage of its forest and jungle in the last twenty years. In addition, its most populated micro – basin, Apatlaco River, it is also the most polluted.

In spite of the potential comparative usefulness of these data, there are questions about apparent observable contradictions between indexes and the social situation they allegedly describe in several states. It is difficult to accept some of the conclusions and recommendations. Tabasco, also in the southern part of Mexico, has, for instance, Sustainable Management of the Environment at the highest level of competitiveness, like Morelos, Chiapas and Guerrero. However, Tabasco has the highest national level of environmental devastation. It is clear that we need to go much further in the analysis to confront their development problems and offer more pertinent development proposals, especially with respect to the social dimensions and institutions, after the Washington policy consensus.

After FCCyT's first two years of consulting work, its president reported that a "linkage" between basic research and long-term economic development must be a priority. This was one of the main conclusions of the National Congress for Competitiveness and "science-*industry vinculacion*" (linkage). Although it may not be a revelation on the global scale, they also concluded that:

- This "linkage" and investment must be an integral part of technological innovation processes, because they are valuable for research, businesses and government alike.
- Mexico's economic strategy must incorporate technological innovation processes into competitiveness and productivity processes.
- The business – research "linkage" must be both valuable and useful for Mexican society. That is, it must contribute to Mexican social and economic development.
- Lastly, and very important for this research project, the "linkage" between knowledge and productivity must be approached by productive sectors and by Mexican regions.

Mexico has made several attempts to link science, technology and the productive sector. We can interpret this as a distant contribution to economic development, or at least a push in that direction. As in some other countries, the Mexican Ministry of Science and Technology has promoted partnerships between scientists, businesses and the government since 1987. Under this policy, 11 high-tech business incubators and approximately 12.5 technology-based enterprises were created per year. This program ended in 1997. Nevertheless, the Mexican Ministry of Economics reports that by 2002, 47 business incubators and more than 200 enterprises were in the process of incubation with support of the government, universities and the private sector. We must not forget, however, that 98.8% of the total 2.8 million Mexican enterprises are micro and small enterprises. They contribute to 70% of Mexico's GDP and 64% of its jobs. Nevertheless, most of these enterprises close within two years of initial startup.

Morelos is a neighboring state of Mexico City. Its state capital, Cuernavaca, is only one hour drive from Mexico City, and Alexander von Humboldt called it "the city of everlasting spring". Morelos was also one of the epicenters of the Mexican Revolution of 1910, led by Emiliano Zapata; according to Harvard University history professor John Womack, peasants in Morelos claimed: "We make a Revolution in order not to change" (Womack 1985, p. XI). What they really want was to have back the land that was taken away after Mexico's by the Spanish, that even several centuries after independence was owned by Haciendas. This was one of the main reasons of the Mexican Revolution. Because of this Revolution, Morelos was the last state to become part of Mexico's constitutional order, in 1930, and the last state to be incorporated into the industrializing processes during the first half of the 1970's. Cuernavaca and its metropolitan area is among the five Mexican metropolitan areas with the highest rate of population growth in the last decade.

## 3 The *Inertial* Scenario and the Desirable and Possible Alternative Future Scenario

In the inertial scenario Morelos will keep jeopardizing the sustainability of its natural resources and its development. In the last 20 years, Morelos has lost 22% of its jungle and 7% of its forest. The region's water availability is clearly enough (we only consume 40% of it), but we will keep contaminating it with residual water because of the lack of proper drainage and water treatment plants, the use of ravines – at least 50 of them across Cuernavaca – for domestic and industrial water and rubbish disposal, and the use of 26 open landfills. Morelos gathers less than 50% of the garbage its population of 1.6 million people (cf. INEGI 2006) produces, approximately 1,338 tons per day.

In an *inertial* scenario, 70% of Morelos families will continue to live under the poverty line, earning less than 170 Dollars per month; the per capita state product, as in the last 15 years, will be under the national average , and ranked in the 21st position in the country; 97% of its business will have 10 employees or less, and pay its workers an average of 3,000 Dollars per year, in contrast with those business with more than 250 employees, paying each of its workers an annual income of 10,919 Dollars. Morelos and Mexico are part of Latin America, the world's most inequitable region.

In an inertial scenario Morelos' working productivity will continue being 29 times lower than the national index in all municipalities but five.

## 4 Morelos' Science and Technology Resources: a Bridge between an *Inertial* and a Plausible Scenario of Development

Morelos is only second to Mexico City in terms of its number of per capita "national researchers" – a renewable designation given by the Mexican government. Morelos also hosts three of the largest research institutes in the country, in addition to another 36, six of which are part of Mexico's National University. Almost all of these research institutes are located in Cuernavaca, Morelos' state capital, one hour to the south of Mexico City. Morelos has four to five times more researchers per capita than Nuevo León, Jalisco, and the State of Mexico – all very productive and competitive states. In Morelos, discoveries have included the most powerful medicine against brain stroke, and the best scorpion antidote as well as the newest black widow spider and "coralillo" snake poison antidotes. Morelos' pilot research of its cervical uterus cancer vaccine is well known among public health specialists, and other vaccines are also being developed, like the one against typhoid fever. Other technology developments include: solar water disinfectant in used plastic bottles, control system simulators and software energy saving tools currently used by the Mexican national energy agency in smart buildings, and bio – fertilizers. In several of these developments, we are more competitive than China, and in others more than even the USA and Europe. For instance, Mexico's National University received 1.2 million Euros from Schering Plough for the thrombosis medicine invention. This was the largest amount of money ever received for one invention.

Most of the strategies proposed or carried out to achieve social impacts do not involve social science knowledge in Mexico and Morelos, other than what government officials could construct by means of public policy. Such officials speak of contributing to the solution of the often globally-defined persistent social problems of health, hunger and the environment (for instance, using the transgenic rice enriched with vitamin A that would prevent children from going blind), but they do not speak of hunger or malnutrition as a result of high levels of poverty in Mexico and Morelos. Thus it is clear: it is not only the responsibility of NBIC fields and researchers to solve these kinds of problems. Therefore, neither should biotechnology nor the rest of "converging technologies" make such promises and assume such challenges exclusively by themselves. Strategies at the national level seem pertinent, but if we examine the conclusions of the Mexican Consultative Forum, we find that there is a very strong emphasis on the regional perspective within Mexico. We have found that other cities, for example Tampere and Turku in Finland, have taken advantage of converging technologies to have a more equitable development (cf. Sotarauta/Srinivas 2005, p. 19). Those cities and their countries build economic policies that follow global economic changes and the national political discourse, but they have invested a substantial amount of time and energy to create their own local interpretations of new forms of development and their respective industries. The key, they concluded, is not the control of global resources (which would be a Utopia), but rather the development of their own local or regional abilities to make themselves part of mainstream trends and global networks, while simultaneously improving their adaptive capacity as a whole. Part of this adaptive capacity is related to local and national institutional capacity to construct new capacities. This has to do with education as well as innovation and technological policies oriented towards the development of individual, organizational and network capacities, which allow local and national sectors to confront the global winds that destroy local productive capacities.

It is true biotechnology science & technology strength for Morelos development (cf. CG 2007; Corona Treviño 2005). However, as biotech specialists recognize, this kind of impact often goes directly into the industry and only comes back in an expensive format to solve the local and national problem. There is where public ethics and commitment are lost.

However, based on my new research results, I would like to add to this the social dimensions that the competitiveness indexes and the post Washington Consensus policies propose.

The construction of the "public action network" – depending upon the way we want to approach it, like Etzkowitz' triple helix theory (cf. Cabrero 2005; Casas 2001; Watkins 2007) – is perhaps the first and the most important social factor that was left behind in research and the Washington Consensus Policies. Most of the time, such networks of alliances and social capital have been simply done by every day business practices. Yet ethics and public debate is necessary at many different levels. At one level, we want to engage in the "Public Action Network" because we want to get results, get things done, and make decisions because of what is at stake: development, ending poverty for a large number of people, large sums of financial investment. At another level, collaboration and trust – elements referred to in the concept of social capital – cannot be simply imposed. In our research, trust has been referred to consistently as the most important factor to be developed by academicians, the government and businessmen (Tapia Uribe 2006, pp. 114, 170). The problem is how to go about it, that is, how to build trust. We have this challenge in many other scenarios of Mexican political and social life.

Another fundamental issue is the line of services, or the products and the economic sectors that will be the platform of science and technology based development. Specialists and business men recommend to never pursue innovation based on a single product, and specialists in our research advised us neither to rely on "a single big invention". Specialists recommend instead constructing a cluster. This refers again to a network. Unger y Chico, for example, defines clusters in several ways: as a network of industries; as a "Regional integrated clusters", as a set of businesses, educational institutions, and governments linked by those capacities related to innovation and development, training, consulting, standardization and others. The set of actors is brought together and, as a result, produce the current or potential competitive advantages of a region or an industry (cf. Unger Rubin/Chico Pérez 2004, pp. 913f.). Another of the latest definitions refers to a cluster as: "A business-led Public Private Partnership, which draws on its members' capabilities to realise new commercial projects" (SSC 2006, p. 7). The same specialist offers another definition, adding the strategic and innovative dimensions: The blueprint explores and seeks to understand the extent to which strategic intelligence tools (knowledge management, benchmarking and foresight) are able to support the creation of innovating clusters

- by enabling firms in a region belonging to the same productive system and business context to foresee the changes in markets and technologies which may affect them,
- by improving their competitiveness through innovation, and
- by designing governance systems capable of fostering collaborative strategies and implementing appropriate business development tools.

As we can see, these specialists even include the concept of governance that I discussed above. On this basis we should carefully choose the clusters and networks that look most promising to construct local development for public action.

It is clear in our research and for other studies (cf. CG 2007; Corona Treviño 2005) that "Life Sciences Clusters" (biotechnology and health cluster) seem to be the most important in Morelos for science & technology based development; together with "Automobile industry, Engineering and Energy" and "Tourism, natural resources sustainability and Agro-businesses" (see Figure 18).

Other studies have identified Morelos as one of four "strategic life science regions in Mexico" (cf. UCSD 2007, p. 1; Corona Treviño 2005). The network construction they propose to carry out in the next twelve months focuses on: "IP strategies, venture investing, strategic partnering in manufacturing and clinical research, as well as basic research partnerships in areas of biomedicine and biotechnology" (UCSD 2007, p. 1).

There are nine Life Sciences research centers in the Morelos region; 556 researchers are working on 53 lines of research. Some of these are: biotechnology, pharmacology, immunology, genomics and bioremediation of environment problems, animal and plant technologies, medical devices, health care, medical information related technology, bioinformatics and telemedicine.

For the sake of a brief discussion in this paper, I will directly present some of the strategies proposed in our research project to build the public action network and I&D clusters in Life Sciences for the Morelos Region:

1. To build a local chain of supply and demand between small and large businesses and I & D services provided by research institutes and consulting firms.
2. To increase or create Public Private Partnership (PPP) for new I & D businesses in the I&D Centers in the techno park, the businesses incubator network, and the local government leader sectors agencies (CCytEM, CEMITT and SEDECO) (see Figure 18).
3. To strengthen PPP between local consulting firms and international ones, together with venture capital if necessary as a first step.
4. To strengthen PPP, by making them more precise and intensive, and create training and education on the job site of technicians, professionals and high degree specialists between businesses, high school specialists, universities and research centers.
5. To establish a high level specialty hospital in the following health care services prevention, diagnosis and treatment: geriatrics, alternative medicine, recreation and prevention, nutrition, mental health and drug addiction, cancer and chronic diseases.
6. To establish I&D nodes in businesses, as needed, including hospitals.
7. To create mechanisms of evaluation and follow up on all of these processes.

The alliance, referred to more specifically as "partnership" or "public – private partnership", needs investment, however. According to experts, the development of a new drug requires in the United States up to one thousand 200 million dollars (cf. Simon Goldbar, Interview in Cuernavaca Morelos, March 2007).


**Figure 18: Morelos Region I & D Competitiveness Systemic Model**

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Automobile industry, Engineering and Energy is another I & D node or cluster for public action. This is a node led by automobile industry and research centers. In this node there are 1,029 researchers working in 14 research centers with 90 lines of research and 826 research projects. Some of the main lines of research are: Alternate sources of energy, together with oil and electricity; turbo machinery; software applied to engineering; control systems; mechanical engineering, and mechatronics. Energy is perhaps the most important factor in terms of Mexico's industrial competitiveness. It is also one of the most debated issues. As in the case of Life Sciences, the cluster would need huge amounts of financial investment. Partnership over this issue must also be discussed. The institutional design for energy production and distribution in Mexico requires a legislative debate, and regions as stakeholders should also not be excluded. It is clear, though, that this is precisely the horizon for working out the social dimensions that include researchers in this field. One of the strong arguments on this issue should be development results and accountability.

The main objective in this automobile, engineering and energy node will be: to systematize and increase I & D and technology based businesses for productive scaling in the supply and logistic chain, in order to increase competitiveness in the areas of electricity, natural gas, oil energy, alternative energies and intelligent control systems, and information technology and communications. Five of the strategies are the same as those of Life Sciences:

1. To build local chains of supply and demand between small and large businesses and I & D services provided by research institutes and consulting firms.
2. To increase or create PPP for new I & D businesses in I&D Centers in the techno park, the businesses incubator network and the local government leadership sector agencies (CCytEM, CEMITT and SEDECO) (see Figure 18).
3. To strengthen PPP between local consulting firms and international ones, together with venture capital if necessary as a first step.
4. To strengthen PPP, by making them more precise and intensive, and as in the other node create training and education on the job site of technicians, professionals and high degree specialists between businesses, high school specialists, universities and research centers.
5. To create mechanisms of evaluation and follow up of all of these processes.

The third I & D node or cluster for public action is Tourism and Sustainable Development: Water, Ravines, and Forest. In Morelos, there are neither tourism research centers nor business leaders in the area. Tourism in Morelos is based on natural resource wealth and weather – Cuernavaca, city of the ever lasting spring –, as well as its pre-Columbian and colonial patrimony. Nevertheless, there are no significant initiatives or projects that link tourism and sustainable development. There are, however, 528 environment researchers in 13 research centers, including the National Water Technology Institute and those working in agribusinesses. In the social and cultural sciences, there are 207 researchers in 14 research centers. They are working on more than 100 lines of research and more than 300 research projects. The main lines of research focus on micro basin sanitation, including ravines, solid waste management, and the management of forest and jungle of federal, state and municipal natural protected areas. We have included in this I & D node agribusinesses. As one of the key epicenters of the Mexican Revolution, the Morelos region has a strong historical legacy in this field, as is written in Morelos government symbol: "the land belongs to those who work it". There are Intensive, organic, spices, flower, greenhouse and other agriculture biotechnology base products. Nationally, Morelos is the first producer of ornamental plants, and 40% of Mexico's spices exported to the US are from Morelos.

As in the case of the other two nodes of I & D, we propose the same strategies.

1. To build local chain supply demand between small and large businesses and I & D services provided by research institutes and consulting firms.
2. To increase or create PPP for new I & D businesses in the I&D Centers in the techno park, the businesses incubator network and the local government leader sectors agencies (CCytEM, CEMITT and SEDECO) (see Figure 18).
3. To strengthen PPP between local consulting firms and international ones, together with venture capital if necessary as a first step.
4. To strengthen PPP, by making them more precise and intensive, and create training and education on the job site of technicians, professionals and high degree specialists between businesses, high school specialists, universities and research centers.
5. To create mechanisms of evaluation and follow up of all of these processes.

## 5 Final Comments

This is the I & D scenario we have constructed, between a desirable and possible one: more competitive, fair, and sustainable than the inertial future scenario, based on Morelos' scientific and technological resources. We have identified critical scientific and technology developments as well as conditions, responsibilities, and strategies for regional industrial clusters.

These scenarios are not predicted for Morelos development. The events of the past century proved the arrogance of such predictions. These scenarios are proposed as possible ones, and they are offered as a framework of public policy tasks. They appeal to perhaps the most important crucible of culture: our creativity and responsibility. And this is perhaps the reason Alain Touraine maintained that the true engine of social change is not politics and economics, but ethics – that mirror in which we envision ourselves farther and better than what we are, as we would like and as we should be.

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# On Qualified Use and Application of Knowledge

*Ladislav Tondl*

## 1 By Way of Introduction

Since the early days of his studies on communication processes the author of this article has been interested in what is perceived as an active role of the recipient of statements and the related topics pertaining to the reduction of data and messages, and the issues of data relevance. His first work devoted to these subjects, co-authored by the distinguished mathematician Albert Perez, was published by Père S. Dockx and Paul Bernays in a highly prominent book on information and prediction in science as early as in the 1960s (cf. Perez/Tondl 1965). Of considerable significance for the purpose of an information-based evaluation of the rate of relevance, a topic also discussed in some other works by the author, has proved to be recipient's level of training and overall competence, his ability to select and apply adequate data and knowledge. This is also concerned with some specific restrictions in data and knowledge applications, notably in connection with technical solutions. This, in turn, is closely associated with the theme of all-round evaluation of prepared or planned technical artifacts and their impacts, hence a domain traditionally called "technology assessment". It was Tadeusz Kotarbiński who encouraged the author to write his first work on these issues. The topics of qualified as well as responsible use of knowledge are also bound up with problems relating to the boundaries or conscious restrictions imposed on some applications, and also to value-related and primarily ethical requirements. (One of the first meetings on these topics to which the author of this study had been invited was convened in 1991 by the Royal Academy in Canada and immediately afterwards by Toronto University – cf. Tondl 1996).

## 2 Motives and Sources of Knowledge Management

Acting somewhat automatically, we presume that many terms, expressions and kindred concepts are thoroughly understandable to all and sundry, that everybody understands their meaning and that, therefore, there is absolutely no need for their interpretation. This assumption is definitely fully justified in an ordinary conversation and interview held within a small group and when using common parlance, when talking in a professional group whose communication revolves around generally comprehensible themes, etc. Much less justified is this assumption especially in case of the mass media, which usually conceive and formulate their messages tailor-made for a "universal recipient" whom they expect to be able to guess quite easily the actual meaning of newly coined words and terms, assuming that he is capable of grasping the meaning from the context or through frequent repetition. In spite of this traditional and long-repeated practice, what really holds true in this context is an analogy to the well-known Latin formula: "si duo accipiunt idem, non est idem", i.e., the finding that each communication process has not only its own source, its originator or author, but also its recipient who, as a rule, is not equipped with a universal competence to be in a position fully and adequately to grasp the meaning of the message received, including its full comprehension and use of the knowledge thus obtained. That is also why, a specific – usually previously acquired – knowledge competence is essential for receiving, comprehending as well as using newly acquired knowledge. After all, the sequence of specific thematic areas in the education process is adjusted to this particular goal to a large extent. It is common knowledge that in lifelong education programmes and courses, relationships between the terms delineated a priori, and those appropriated a posteriori must be respected. These contexts, too, are known to apply the well-established principle of cognitive activities: We tend to view everything newly acquired, newly discovered, newly emerging or newly unveiled through the prism of our existing knowledge and experience, as corroborated by the means used to denote or name newly learnt objects, processes or situations associated with those previously learnt or utilized semantic spaces.

While those particular spheres of action conducive to new discoveries and new knowledge are undoubtedly challenging, and require highly qualified, creative and inventive subjects, no less demanding are those domains of management and decision-making connected with fruitful, efficient while responsible use of knowledge and the methods of possible solutions of newly emerging problem situations. Looking back at the corpus of experience amassed by science and development in the past century, we may single out two personalities who coordinated research and development efforts, while managing the process of application of the results of such endeavors in major projects.

During World War II it was Vannevar Bush, a scientist at MIT, who was commissioned to coordinate research and development projects carried out by large teams consisting of leading US scientists, joined by dozens of European émigré scholars, who were expected to contribute to Allied victory in the war. This applied not only to the development of nuclear weapons and to the Los Alamos laboratories, but also to fire control and to the well-known issue of prediction, application of antibiotics, use of the radar, to the breaking and interpretation of secret codes, and many other tasks Bush was in charge of as the Director of the Office of Scientific Research and Development (cf. Bush 1945).

The other personality who succeeded in coordinating and integrating America's scientific, research and development projects was Alvin M. Weinberg, head of the President's Science Advisory Committee and Director of the vast National Laboratories in Tennessee. Weinberg participated in the programs designed to offset the so-called sputnik effect, and conceived a program of what was characterized as the "information society" (cf. Weinberg 1963, pp. 7ff.). (As a matter of record, the author of this study met Weinberg at a European-American seminar on the prospects of science held at what was then the Yugoslav nuclear centre Herceg-Novi in 1968; after the Soviet-led invasion of Czechoslovakia Weinberg exerted efforts, though eventually unsuccessful, to invite the author to the United States.)

In actual fact, the topics tackled by those teams as well as the programs and projects pursued by groups of specialists active in many different branches that were coordinated by the personalities mentioned above almost half a century ago, and, undoubtedly, also many other research teams and projects, had not been limited solely to the issues of the past century. Also at present, we have to deal with many other – no less serious – problem areas, such as e.g. climate change, environmental problems, issues pertaining to new sources of energy, and their limits and risks. One may also consider the nature of the current and perspective level of our civilization or a civilization facing a high level of risks. The task of reflecting the actual nature of such comprehensive and multidimensional problem areas is inconceivable only on the basis of the knowledge of a single branch, a single discipline or a single thematic field. There arises the need for pursuing such activities, challenging in terms of their intellectual and knowledge requirements, which are sometimes described as *knowledge management* or *knowledge mastering* (cf. Tondl 1998).

Knowledge management makes it imperative to ensure at least the following substantial steps, including subjects competent enough for their reliable implementation:

- Well-defined knowledge areas essential for a reliable attainment of delineated goals, including involvement of qualified and competent subjects for their application.
- Necessary, accessible or available means, including prerequisites in terms of capacity, personnel and other preconditions.
- Vital measures aimed at integrating and coordinating applicable knowledge as well as means, while determining their relevance and rate of participation in the individual constituents of an overall solution.
- An overview of advantages and disadvantages, usefulness as well as losses or risks posed by alternative procedures and solutions.
- Well-defined boundaries to the usability of the individual methods, approaches and solutions, and their secured compliance within a plan of inevitable and necessary procedures.
- A course and sequence of individual stages necessary for finding a solution, vital checkpoints or phases for monitoring and assigning responsibilities.

Naturally, knowledge management may also comprise some other components, which may concern some other conditions as well. In specific situations, one may view as significant reflections of the prevailing prerequisites and feasibility terms, other phases on the time axis, other shapes or forms of applicability of the existing results, etc.

The actual content of most components of knowledge management is shaped by the prevailing nature of those types of action in which specific knowledge will be used or to which it will be applied. Seen in this light, it is definitely crucial to distinguish the main spheres in which the acquired and available knowledge will be employed. The well-known and oft-repeated formulas claiming that knowledge will serve purposes of practical life, that it will be duly applied, actually say very little of the genuine aims, failing, as they do, to take into consideration the quality or level of such practical use, failing to respect the target orientation of such application, what and whom it benefits, and other possible contexts. Of equally low informative value is the phrase claiming that science and research "serve the people", as proclaimed, until quite recently, by the totalitarian power in this country and its ideology whose representatives made use of such claims as a smoke screen to cover up their own partial interests. After all, the entire complex of "service" or "serviceability" has always been more or less a hindrance and obstacle to any real upswing in creativity and initiative, and in cognitive activities as well. What appears more acceptable in this particular context is the thesis that the gist of knowledge application lies primarily in incorporating hitherto known and time-tested findings into decision-making processes, into procedures of reasoning, which constitute starting points for selecting goals, means and conditions of different types of human actions, primarily those types of action in which knowledge is inevitably engaged.

But man applies knowledge virtually in all steps, in all decisions, notably because he is endowed with a memory, that is capable of accumulating experience, that is able to make ample use of the conditioned reflex. Nevertheless, we can single out some areas of human rational actions in which the systematic engagement of hitherto accessible and available knowledge is a *conditio sine qua non*, i.e. an absolutely inevitable condition. These areas cover primarily organized cognitive activities themselves, i.e. the sector of science and research, including processing, designing and presenting the results of cognitive activities. This, in turn, is connected with the issue of qualification requirements for such activities and, therefore, with the fact that acquisition of new knowledge presupposes that these procedures invariably involve both specific hypotheses concerning what was unknown or what is newly discovered, based on the hitherto available knowledge, as well as linguistic means and means of expression, terminology, time-tested and already known methods, empirical and experimental tools, etc.

Another major sphere of application and use of hitherto known and verified knowledge and experience is procedures and methods associated with schooling and the educational process in general. After all, it is a matter-of-course that only people who themselves are endowed with the light of vision, who are capable of conveying and presenting knowledge in an interesting and convincing fashion can educate and edify others. Furthermore, the ways and means of diffusing knowledge are also governed by some specific rules, and not only those involving the need of respecting the age and maturity of pupils, but also rules regulating the contexts and especially the sequence of different thematic fields, according to which entry into new domains, i.e., areas novel to the recipient, calls for mastering and appropriating other fields. It is, therefore, quite evident that the disciplines involving the processes of upbringing and education require an integration of many important insights and contexts, including recipients' intellectual and competency levels, contexts pertaining to the thematic fields being disseminated.

Probably the most closely followed domains of human activities, in which acquired knowledge is applied, and this pertains primarily to knowledge of a different nature or – to put it succinctly not only "the knowledge that" but also "the knowledge how" (know-how) – are spheres of creative activities. These are pursuits enabling man to satisfy needs, including the elementary and essentially intrinsic needs as well as needs for self-fulfillment, while attaining acknowledged and required values. A pride of place in these domains is held by those activities through which man creates various sorts of artifacts, and hence also technical artifacts, cultural artifacts and works of art, and, undoubtedly, also artifacts of social, political, organizational or economic nature. Quite evident in this respect is the role of knowledge, both previously acquired and verified by experience, as well as new findings obtained in the sector of technical artifacts, as spelt out by their designation coming from the Greek word "techné", which originally denoted a skill or an ability to perform a specific action. Seen in this context, one can hardly fail to notice that, in addition to knowledge, participating in the fields of technical artifacts are also recognized and acceptable values, taking part in their genesis, development, innovation procedures as well in decisions through which certain types of artifacts are discarded, replaced by others – more perfect or better suited – to satisfy the existing needs.

The actual share of such values in a sequence of changes, in innovations or in the emergence of new patterns, models and their preferences is, however, still more pronounced in those spheres of artifacts, which are generally characterized as works of culture, works of art or artifacts of intellectual or social nature. This also holds true of actions, pursuits and measures geared to satisfy specific interests, needs associated with self-fulfillment and entertainment, applying all the more so because such interests or needs are – to a considerable rate – generated by the media, the advertising industry or by artificially created models, which, in turn, may cause doubts about the actual values applied in such activities, and – at the same time – about an absence of a more serious kind of knowledge. (This, however, is a different topic pertaining to the issue of ignoring knowledge or not respecting available knowledge.)

# 3 Structure of Knowledge Application

Procedures in which specific knowledge is applied may appear as "one-off" acts. In actual fact, practical application of specific knowledge invariably proceeds in a whole series of interconnected steps, thus having a specific structure, where the elements of such a whole are mutually dependent or contingent and where the relations and interconnections of those elements must be respected. We presume that knowledge, and – as we should stress – always adequate knowledge as regards the other elements of the whole and in view of the goals of the selected action, is applied in a decision-making process. This is associated with a choice of objectives and means of that particular action that is being – or is to be – started to effect a desirable change, eliminate identified shortcomings or risks, or – to put it in other words – participate in solving a specific problem situation. One may readily agree with the view expounded by Karl Raimund Popper that goal-directed rational actions filling human life are, essentially, solutions of problems.

As a rule, each solution of a problem situation is preceded by a stage that may be described as problem identification, as recognition or awareness of the situation in hand, for which a change is desirable, in which a specific shortcoming or anything that has to be eliminated, surmounted or replaced by something else, by something we perceive as more suitable, perfect or profitable, has been duly identified. In this way, we create an image of a desirable state or situation, which has to replace the actual situation. Such an image then constitutes the core of a considered target orientation. We then tend to associate certain positive anticipations with the target orientation of such a considered or planned action. A case in point illustrative of such a problem situation is the process of identifying a source of disease on the basis of ascertained physical or mental problems, and related need for medical intervention and thus for a pattern for shaping a diagnosis and subsequent therapy. The actual pattern or structure of such a situation comprises the following significant elements in particular:

- Identification of an unsatisfactory state, for instance pain, specific troubles etc.;
- Determination of the main signs or manifestations of such a state, i.e. symptoms;
- Identification of the patient's overall situation, his medical history;
- Primary hypothesis of a diagnostic decision;
- Confirmation of the primary decision through additional evidence or tests.

This particular pattern has the nature of a judgment, whereby its premises are formed by known generalizations, i.e. medical knowledge making up a corpus of findings expressing interdependence of specific sets of symptoms and diagnostic decisions, available empirical records encompassing identified symptoms and patient's known case history, and – in conclusion – a diagnostic decision itself. It is only natural that such a pattern may be expanded and supplemented, both by extending empirical records, i.e. by means of further tests, for instance through laboratory testing, by engaging further knowledge, for example by inviting other specialists to form a medical council.

The pattern given above for solving a problem situation (cf. Tondl 1986, 1997, 2002) is based on contexts of *generalizations*, i.e. formulations characterized as scientific laws, hypotheses (usually confirmed hypotheses), empirical generalizations or generally valid formulas similar to laws involving delineation of a thematic or problem area, actual *empirical evidence* describing identified states or situations, a known sequence of changes of those states, certain specific *human actions* or interventions and their known or verified impacts. In decision-making, a problem situation is usually accompanied by a specific *expectation*, i.e. anticipation of possible states that occur without human actions or interventions, and expectations of possible impacts or effects coming in the wake of such interventions. Incorporation of the element of expectation into the pattern of decision-making about a problem situation, whose result is a decision on the start-up of a specific human (practical) activity or intervention, means that this particular decision-making has its own prognostic dimensions based on the knowledge of an actual situation, the knowledge of a specific thematic or problem field to which this situation belongs and the knowledge of effects or impacts of possible or practicable interventions in the given problem area.

The backbone of the decision-making procedure given above and, at the same time, of analogous procedures operating with generalizations or with rules pertaining to a specific domain or a well-defined thematic field, with singular data concerning states or situations in the same area, are deductive procedures (often characterized as logical deduction or inference). Such inference has the character of deterministic or merely probabilistic deduction, displaying the nature of a solution of a justified recommendation, i.e. substantiated by the level and quality of the knowledge employed as a premise used in that particular reasoning. Hence, it is not a command but a recommendation given to the subject of such activities, which are selected for the purpose of tackling a relevant project situation and for the purpose of meeting its outlined objectives.

Therefore, the procedures of knowledge application while searching for or determining the nature of a problem situation are known to have the nature of argumentation for a selection of an identified project situation. This also means that they do not relieve of responsibility that particular subject who has found a specific solution of the given situation or who has initiated such a solution through his instructions or commands.

## 4 The Quality of the Solution of a Problem Situation

We usually give most of the credit – and usually also assign the main responsibility for a successful solution of a problem situation, its quality and usefulness – to the subject of the solution concerned. Such a subject may be a physician in case of a therapy applied to cope with a medical problem, a designer and author of a technical project conducive to safeguarding desirable measures or functions, or a guide who succeeds in leading us through a difficult terrain to our planned destination. Credit is undoubtedly due to the subject of the process of solving a problem situation, provided that subject is, indeed, endowed with necessary and adequate knowledge, and has at his disposal essential technical instruments, needed capacities, etc. Seen in this light, is it crucial for a physician to acquire an extensive corpus of knowledge and command specific practical skills and thus prerequisites requiring long and demanding studies, practical experiences, which are being constantly supplemented as well as checked, as confirmed by existing systems of certification, accreditation, attendance at meetings and conferences that report on new findings and methods and introduce an ever expanding and ever more complex array of diagnostic technologies, knowledge on new operating and therapeutic procedures and information on latest medical risks. Even though current medicine does develop the age-old traditions going as far back as to ancient Greek medicine, doing so primarily in terms of its ethics, the present-day curative procedures have been developing and improving very fast indeed. In a similar vein, contemporary designers or technicians working in most technological branches have to cope with new requirements and knowledge prerequisites. They have to operate with a greater extent of data and knowledge, using more extensive databases, usually in digitized forms, complete with application of information technologies and computer graphics. They have to be able to depict simulations of the actual operation of planned and designed equipment, taking into account eventual, albeit probable, risks. Indeed, the threat of possible risks, accidents and adverse – mainly health and environmental – impacts has grown to be an organic component of today's creative technological thinking.

It is only natural that each successful action, each solution of a problem situation, each package of measures focused on attaining specific goals or desirable results makes it imperative to engage specific knowledge. This knowledge, however, usually does not lie in the centre of general attention. More often than not, attention is concentrated on the subject of such activity or on representatives of the powers that be who decide on the start-up and implementation of those creative pursuits. This eventually leads to such general statements claiming this or that king or prince built a certain palace, created a highly praised cultural monument or another grandiose work. If those in power had, indeed, given an impetus to a project or decided about its implementation or taken some credit for the achievement of some specific results which have managed to retain their permanent value, this attests to their good level of knowledge or the high standards of knowledge of those whose advice they had followed. But we also know quite opposite examples, when overly self-confident holders of monopoly power mistook the possession of power with the possession of adequate knowledge, focusing their decisions and commands in keeping with their ideology based on the visions and values anchored in the past, e.g., in the 19th century and in the early days of the industrial revolution. (A well-known outcome of this particular focus in our country was an upswing of its heavy industries and the material- and energy-intensive branches that polluted the environment and virtually amounted to nothing else but an extension of the hitherto known processes and procedures.)

Having said that knowledge is a substantial prerequisite for selecting the most suitable goals, for finding the best solution to a problem situation, surmounting serious obstacles or dangers, choosing adequate instruments, resources and capacities, we mean knowledge in the broadest possible sense, i.e., not only written or verbal knowledge but also any findings incorporated into a body of confirmed experiences and skills, knowledge of anticipated benefits and possible risks, knowledge taking into account the existing value, cultural, human and social aspects, and thus, also those dimensions of knowledge collectively known as "wisdom" (cf. Tondl 2008). This also means that a sophisticated and wise knowledge application, as part of a package of goal-directed activities or a solution of an acknowledged problem situation, proceeds with full responsibility, with regard to those who are to benefit from – or who are eventually jeopardized by – this application and related action, with regard to the consequences or impacts it may have. (This is also spelt out by the ancient rule formulated in Latin as “Quidquit agis, prudenter agas et respice finem”, i.e., whatever you do, do it with the knowledge of and regard for its consequences.)

It is usually insufficient to have only the command of available knowledge for effecting a desirable change, for tackling an identified and acknowledged problem situation or for attaining outlined goals; it is likewise crucial to have at one’s disposal a well-justified and competent decision, usually motivated by other reasons as well, for instance by the conclusion and conviction that a planned change or a considered project is, indeed, necessary, indispensable, that vital means, resources and capabilities are really available, that such a required or planned work will be positively received and appreciated. To put it in other words, there is a need for what can be characterized as a *value atmosphere* or value situation. Expectation of a project’s predominantly positive reception and appreciation is usually also involved in the process of starting up a real action or making a necessary solution. This also means to say that a corpus of knowledge, engaged in and applied to solving such a problem situation, is used primarily for assessment and decision-making on the conditions, prerequisites as well as *feasibility* of a specific solution, of a certain goal-directed action. However, implementation proper or solution itself are stimulated by other factors as well. This may be aptly demonstrated by an historical example. The knowledge that the Earth is round confirmed expectations that a westward journey from Europe could offer a shorter way to India or, in other words, to the sources of highly demanded Oriental spices, but the decision itself to set out on such a journey was also stimulated by ambitions to find a faster and easier path to those resources.

Even though the share of a specific set of knowledge in rational actions and especially in the quality of their results, whether this involves a solution of a problem situation, production of desirable artifacts, attainment of stipulated goals or whether other dimensions of such activities happen to be in the centre of attention, is quite indisputable, one cannot and should not question the specific role and impact of values on the overall focus of such rational actions either. Furthermore, the impact of values and a value-related atmosphere, of value-shaped models, preferences and expectations need not be expressly spelt out, it may be perceived as a matter-of-course or something generally acknowledged or anticipated. Indeed, the share of values and assessment will come out into the fore especially in those stages of decision-making and organizing activities, where available or applicable knowledge offers alternatives, namely alternatives comprising available and practicable goals as well as alternatives to suitable methods, approaches and available resources.

## 5 Knowledge Application, Selection and Integration of Knowledge

The start of the process of solving a problem situation, of a package of goal-directed activities aimed at achieving outlined targets and desirable states or effecting changes or eliminating specific obstacles or risks usually stems from a decision-making process. This particular procedure not only outlines goals and stipulates applicable methods and means, but also applies specific knowledge, while evaluating its adequacy and relevance with regard to given objectives. It is necessary to create at least the following sets of knowledge and related singular data for decision-making on the start-up of target-oriented action in the given general sense:

- Knowledge of the domain or thematic area where changes are considered, where specific solutions of problem situations are planned or where achievement of specific desirable target states is envisaged;
- Knowledge of the initial or problem states and knowledge of planned changes of such states, new and desirable or envisaged states;
- Knowledge of the necessary resources, capacities and requirements of material, energy as well as personnel nature that are vital for the attainment of a target situation and requested states;
- Knowledge of the feasibility of necessary procedures or measures, complete with an awareness of potential advantages and risks posed by such procedures, including possible, anticipated or merely probable impacts, and not only actual or just temporary ones, but also impacts likely to emerge in future stages.

But this is only a very general description of human goal-directed action, which may be characterized as natural human efforts to reduce the rate of indeterminateness or risks within our immediate as well as wider surroundings, to upgrade the qualitative or cultural level in those environs. It is only natural that such sets of knowledge and structures of their relations considerably differ in form, content and functionality, when efforts to alleviate pain and eliminate difficulties accompanying treatment are involved, when diagnosis and therapy are employed, when a project and subsequent construction of a transport link between two parts of a large city are planned. Framework of relations among individual sets of knowledge in view of the target orientation of a specific type of rational action is identical or partly analogous.

Seen in this light, knowledge application is primarily an entry of individual knowledge corpuses into a framework of relations of the individual types of knowledge in decision-making procedures that decide about the start of a series and sequence of action whose implementation as well as succession also guarantee the direction and attainment of a planned target state. Moreover, some major rules, such as primarily those guiding the consistency of the individual types of knowledge, the rules of correspondence of various types, rules associated with the relevance of some kinds of knowledge and empirical findings or other important rules regulating relations or dependence of different sorts of knowledge, must be respected. The consistency rules presuppose that data containing empirical evidence and generalizations or other general rules are related to the same semantic space. The correspondence rules lay down the extent of dependence of the conceptual terms used in generalizations, and the terms used in expressing empirical evidence.

Of great importance for efficient utilization of various data and knowledge offered for decision-making procedures is that special quality of data and knowledge, which we usually characterize as data relevance and knowledge relevance. Relevance describes the information value of a specific statement and its content in view of the task in hand, in view of the knowledge to be employed to solve a given assignment, a specific problem situation or other target orientations pertaining to an action being pursued. But relevance is invariably a relative phenomenon, i.e., a specific statement yielding new data, and new knowledge is perceived in view of its consistency with certain generalizations or rules, in view of its applicability in decision-making on possible measures or interventions. In a similar vein, we consider the relevance of known or verified knowledge in the shape of generalizations or rules in view of the tasks being solved and the procedures or means planned to be used therein. Data and knowledge relevance may have either a greater or smaller extent, it may, therefore, have the nature of a specific rate or measure. As an instrument of qualification, this particular rate appears – quite undoubtedly – best suited for different information rates that have been developed in mathematics and the semantic theory of information. This particular solution of quantification is based on probability attributes of all the elements of such relativization. This is usually quite difficult and not always sufficiently reliable. Problems seem to lie in the fact that – as a rule – we tend to operate with different sources of values of probability characteristics of the applied data and knowledge, for example values identified in differently reliable and variously representative sets, ascertained only from estimates or expectations based on experience. Only a final set of prerequisites may be taken into consideration in case of identifying such characteristics. In many instances, even adequately representative sets are prone to fast and often unexpected changes. Seen in this light, it is vital to emphasize that the rates of semantic information, and hence, thus constituted rates of relevance are invariably relativized towards the status of our “hic et nunc”, i.e., here and now. That is also why a critical and restrained approach to the hitherto available rates of relevance as well as to estimates, anticipations and forecasts dependent on them is both necessary and useful.

Restraint and critical thinking are vitally needed in assignments that have to take into account data and knowledge of different types and of various domains. Most challenging issues and related tasks can hardly make do with a single type and a single source of knowledge engaged in a given situation or when solving a specific task. We take it for granted if a physician, while diagnosing a patient and determining a subsequent therapy, takes into consideration not only the symptoms that have been established empirically, but also asks for a battery of laboratory tests to be made and experimental findings to be supplied. What usually turns out to be less obvious is when an experienced and well-qualified physician considers the patient’s age, his overall case history, his psychic condition, social status and many other circumstances. A designer of a transport link connecting two localities will naturally take into account the nature and diversity of the terrain, anticipated traffic intensity, requirements for terrain adjustments, and a long series of other conditions. A designer, well aware of all the contemporary and current requirements, will also respect the distance of residential areas, anticipated noise and exhalation impacts, availability and connection of other transport systems, and other types of knowledge as well as anticipated forecasts. One may, therefore, say that the knowledge requirements laid on contemporary well-qualified and challenging projects can hardly be “accommodated” by a single knowledge discipline or a single scientific or technical branch. This gives rise to a situation where even manipulation with knowledge of different types and domains, and its expedient utilization and engagement in demanding comprehensive projects should be efficiently controlled and managed.

As things stand, the process of integrating different knowledge domains working and operating with different means of expression, with different terminology as well as diverse scales is definitely no easy or simple matter. This holds true especially of the mutual relations and integration efforts in natural science and technical branches on the one hand, and the disciplines dealing with humans, traditionally – but not very aptly – described as “social” (possibly better called “humanitarian”) or “spiritual” on the other. However, it is, likewise, more than evident that all the issues, difficulties and notably conflicts and risks posed by the contemporary society have their own “human”, “spiritual” as well as “value-related” dimensions. Furthermore, the task of reviewing the role, the relative weight and the function of the individual dimensions, while always doing this in the light of the particular task in hand, is neither easy nor simple. One can hardly ignore that many narrowly specialized experts have a tendency to overestimate the role of their own professional subjects and their related insights and criteria. When tackling these assignments, which we call “knowledge management”, the ultimate task does not involve solely an expedient integration of various types of knowledge and criteria related therewith, but also an integration of different approaches and views as well as an assessment of the rate of relevance of the individual insights, approaches and criteria. When solving such assignments, there are many values and interrelated human rights and freedoms, as well as our own global responsibility for ensuring and preserving those values, that come ever more strongly into play – in addition to various types of knowledge associated with a broad gamut of contemporary issues, prevailing civilizational and cultural standards, and with sustainable development of the human race.

# 6 On the Significance of the Subject of Knowledge Application

The topic of knowledge application and the key issues of “knowledge management” also encompass the matter of caring for – or rather keeping an eye on – the subject of knowledge application, or rather those human subjects who decide about the use of specific knowledge in a bid to attain or secure certain major goals. This is primarily concerned with the fact that some of the targets may eventually prove to be beneficial solely for a limited section of human society, involving inhumane methods or procedures, posing serious threats to human lives, health and supportable living environment. Voices expressing – and frequently openly clamoring for – the attainment of such goals have not only persisted, even following the blood-curdling experience of the 20th century, but we are now hearing them coming from the lips of proponents of fundamentalist ideologies, heralds of racist nationalistic or religious violence or various forms of terrorism. (Seen in such contexts, we can hardly avoid posing the cardinal question: how long are we going to tolerate such voices, to what lengths are we prepared to go while looking on and conniving such abuses of the principles of tolerance and the freedom of action and expression, which are jeopardizing our liberties and the security of other sections of the human community.) Indeed, there is a danger that the results of human learning, new products of science, research and technological development may be abused as well.

We may take it as quite natural that people in many professions utilizing extensive and often demanding knowledge are required to meet relatively considerable knowledge requirements. Judged by the actual nature of these professions, such requirements may be divided into several different groups, of out of which the following may be seen as particularly significant (cf., e.g., Tondl 2001a, 2001b, 2007):

- A method of checking the application of knowledge and also skills, reproduction of the application procedures by means of a package of practical operations which, in their entirety, are geared to confirm the application of previously acquired knowledge, especially the type “knowledge how”, may probably be perceived as an old traditional group of instruments designed to verify compliance with those requirements. A case in point is the set of procedures known from what used to be called journeyman’s exams. Indeed, elements of checks of this kind have retained their significance as part of certificates issued to teachers, physicians and some other types of professions.
- Another kind of checks of competencies possessed by different subjects and their capacity to make ample use of their acquired knowledge lies in various tests, testing texts, written assignments. These forms are traditionally used at vocational schools, at higher-level schools. The importance of not only correct and apt reproduction of pertinent knowledge but also its contextualization in various assignments or problem situations is emphasized in this context.
- Some demanding professions have in recent years witnessed stringent checks of the level of competency and professional qualification, making it possible not only to verify the actual quality of the results of such activities but also their effects and impacts in broader contexts as well as over a longer period of time. These involve various forms of certificates or certifications.

Even though we ought to welcome an extension of these and similar forms of assessments and checks of competence prerequisites for some challenging activities, the actual field of their operation still leaves much to be desired. It is limited primarily to the work of medical specialists and teachers, while other demanding and highly responsible professions stay more or less on the sidelines. There can be no doubt that members of some other professions should also be made to apply in their operation analogous requirements in terms of checks and evaluations of their crucial competencies. The author deems it necessary to offer here yet another recommendation relating to the operation of demanding and responsible activities. In addition to requirements for knowledge, experience and other competency prerequisites it is impossible to omit personal value prerequisites, notably moral integrity, an impeccable moral credit and a sense for personal and social responsibility. This applies primarily to activities involving managerial, normative or legislative roles in charge of larger social, economic and administrative units.

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# What Is EU Research Policy?

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Some policy analysts question the very existence of an EU (European Union) research policy. At first sight, their doubt may seem understandable. For an outsider the complex bureaucracy, legal constraints and political environment within which European policies are created, developed and implemented often overshadow the sometime slow but steady progress. Currently EU research policy builds upon three fundamental principles: (1) we have entered the "knowledge-based society"; (2) increasing R&D spending is necessary to guarantee competitive success; and (3) political guidance is an indispensable tool for the direction of research. Each one of the three principles contains a degree of misapprehension. This paper aims to address the above issues in an unbiased manner. For the sake of historical correctness and to help newcomers, the true background of the European Union's research is also outlined.

This paper describes the situation at the end of 2009.

## 1 Brief History of the European Union

The motto of the European Union (EU) is "In varietate concordia"[1]. The expression is also a symbol of the challenges and rewards of Europe and its unification process.

Today's EU is the result a long process of negotiations and co-operation in Europe.[2] Although the process began after the Second World War (WWII), its intellectual roots go back much further. The two World Wars had left most of Europe in ruins. It prompted the search for a lasting peace. There was a need to bring about lasting reconciliation between France and Germany. The Europe-wide devastation of WWII brought a realisation among enlightened European visionaries. Non-violent co-operation was the only way to ensure a peaceful and prosperous future for Europe.

Resulting from the remarkable effort to rebuild Europe, "fractious nations that had fought one another for more than a thousand years have learned to interact peacefully and collectively on the global stage, in less than 50 years. What is more, the EU has been an engine of prosperity for Europe, lifting millions of families out of their post-war poverty and squarely into the middle class affluence that so many Europeans now consider to be their birthright" (Hofheinz 2005).

The most prominent "architects" of the European unification process were two Frenchmen and a German: Robert Schuman (1886-1963), Jean Monnet (1888-1979) and Konrad Adenauer (1876-1967). Their intellectual and moral weight provided confidence in the "European project" during its infancy. It has become what today is known as the EU.

The origin of the EU goes back to the creation of the European Coal and Steel Community in 1952 by six countries: Belgium, France, Italy, Luxembourg, the Netherlands and the German Federal Republic (West-Germany). In 1957 these countries established and added the European Economic Community (EEC) as well as the European Atomic Energy Community (EURATOM). In 1967 these three bodies were institutionally merged and referred to as the European Communities. Since 1992 it has been known as the European Union.

To date, 21 more countries have joined the European Communities in six "waves": in 1973 Denmark, Ireland and the United Kingdom; in 1981 Greece; in 1986 Spain and Portugal; in 1995 Austria, Finland and Sweden. In 2004 the EU underwent a historic enlargement by ten further countries joining – eighth from Central- and Eastern Europe and two from the Mediterranean region. These were, respectively: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, as well as Cyprus and Malta. Finally, in 2007 Bulgaria and Romania became EU members. The major institutional steps leading to the European Union in 1992 are summarised in Table 28.

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1 „United in diversity".

2 There is a rich literature on this subject, e.g. a recent one is Ocaña 2003. The website of the European Union is a first-rate starting point for studying the EU's history and institution; cf. http://europa.eu/index_en.htm.

Today, the EU is a unique supranational and intergovernmental union of 27 sovereign states. Its smooth functioning is ensured by a number of public European institutions with complementary functions.[3]

Today the EU is one of the largest economic and political entities in the world. It currently sports 494 million inhabitants with a combined nominal gross domestic product (GDP) of €11.6 (US$14.5) trillion in 2006. It is a single market with common trade policy, common agriculture / fisheries policy, and common regional policy. The latter is designed to assist regions within the EU that are lagging behind the average of the EU.

In 2002, the EU introduced a new and single currency, the Euro, with the symbol €. 13 Member States have so far adopted the Euro.

In 2007 a seven-year multi-annual spending plan was agreed on for the period 2007-2013. The plan, called the "Financial Perspective", aims to ensure sufficient resources to finance longer-term EU activities.

**Table 28: Chronology of Treaties Leading to the European Union**

| Year | Treaties |
|---|---|
| 1952 | Treaty of Paris – established the European Coal and Steel Community; *coal and steel related research and technological development formed part of it* |
| 1957 | Treaties of Rome – established:<br>a) the European Economic Community; agricultural research formed part of it;<br>b) the European Atomic Energy Community (EURATOM); research for peaceful use of nuclear energy formed part of it |
| 1965 | Treaty of Brussels ("Merger Treaty") – consolidated the institutional structures |
| 1986 | Single European Act – first major revision of Rome Treaties; *includes a whole chapter on research and technological development* |
| 1992 | Maastricht Treaty – established the European Union, EU |
| 1997 | Amsterdam Treaty – introduced substantive amendments to former Treaties; *includes a whole chapter on research and technological development* |
| 2001 | Nice Treaty – prepared for enlargement by 10 new member states |
| 2004 | Treaty on a Constitution for Europe. Rejected by France and the Netherlands in popular referendum in 2005 |
| 2007 | Reform Treaty – the Member States must ratify it before the next election of the European Parliament in 2009; rejected by Ireland in popular referendum in June 2008 |

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The EU has also taken initial steps to become a major player on the international scene. It has initiated limited common foreign and security policy, and police and judicial co-operation in criminal matters.

The various stages of EU enlargement have turned out to be powerful EU policy tools. The prospect of joining the EU has helped transform Central and Eastern Europe into modern, well-functioning parliamentary democracies.

Taking new Members States on board is a carefully managed process. It must not only benefit the transformation of the countries involved but also the European Union as a whole. The overriding objective is to extend and guarantee peace, stability, prosperity, democracy, human rights and the rule of law across Europe (cf. EC 2007).

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3 These are: the Council of the European Union, the European Parliament, the Council of Ministers, the European Commission, the European Court of Justice, the European Court of Auditors, the European Economic and Social Committee, the Committee of Regions, the European Central Bank, the European Investment Bank, and several decentralised EU bodies. Every six months the Presidency of the Council of the European Union rotates between the Member States. The Presidency organises the work of the institution and is the driving force in the legislative and political decision-making process.

Currently there are three countries in waiting position to become EU Members: Croatia, The Former Yugoslav Republic of Macedonia, and Turkey. The EU has granted each of them "candidate country" status (although only a small part of Turkey is actually within geographic Europe).

In order to join the EU, a country needs to fulfil the economic and political conditions generally known as the "Copenhagen Criteria" (agreed by EU leaders in 1993 in Copenhagen). These Criteria require a secular and democratic government, rule of law and corresponding individual freedoms, and appropriate public institutions. In addition, according to the EU Treaty, all current Member States as well as the European Parliament have to agree to any enlargement.

The current EU Treaty, the Nice Treaty, limits EU membership to the 27 countries – a limit that has now been reached. The proposed "Treaty on a Constitution for Europe" was rejected by public referendum in France and the Netherlands. It should have provided a mechanism to allow further enlargement, as well as a simplification of the EU decision-making process. As a consequence, new institutional arrangements were needed prior to any further and future enlargement. To this end, intensive work had been going on at the highest level with the aim to agree on- and ratify a new so called "Reform Treaty" before the next election of the European Parliament in 2009. The Heads of State and Government of EU Member States signed this Reform Treaty on 13th December 2007 in Lisbon (Portugal). At the time of writing, the Treaty is awaiting ratification by the Member States.

Another unique feature of the EU is that citizens of EU Member States are also EU citizens. They directly elect members of the European Parliament once every five years. Citizens can live, travel, work, and invest in other Member States (temporarily with some restrictions on new Member States). Passport control and customs checks at most internal borders have been abolished (according to the so called "Schengen Agreement"). With this development, the "the Four Freedom" within the EU is being implemented, i.e. free market in goods, services, capital and people.

Within the EU, all citizens benefit from having neighbours that are stable political democracies and prosperous market economies. In the opinion of the authors of this article, this is the most significant achievement in the long history of Europe.

During its evolution, the EU's main challenge has remained the same from the beginning: "simultaneous cooperation, which unites the people; competition, which stimulates the economy; and solidarity, which protects citizens" – as stated on various occasions by Jacques Delors, President of the European Commission during 1985-1995. He was the most outspoken and publicly visible European political personality in recent times, "grandeur" of European politics.

# 2 European Research Co-operation

Some policy analysts question the very existence of a European research policy. At first sight, their doubt may seem understandable. For an outsider the complex bureaucracy, legal constraints and political environment within which European policies are created, developing and implemented often overshadow the sometime slow but steady progress.

## 2.1 Genesis and Development

The first intergovernmental Treaties that established European level co-operation limited scientific co-operation to specific fields: coal and steel; agriculture; and nuclear energy (see Table 28). This restricted research mandate remained in effect and was first broadened after thirty years.

In the absence of a mandate and corresponding research policy the effort focused on *co-operation* in selected areas. This evolved into *co-ordination* of projects with potential high value-added. Today, the EU is promoting *integration* of European research into a common "research area".

This journey of more than fifty years has been far from straightforward. It has involved lengthy and difficult negotiations, often at the highest political level. In this process the European research policy has been born and is still maturing.[4]

Already during the 1960s the technology gap between Europe and the US, the brain drain from Europe to the US, and the increasing number of US high-tech companies' moving to Europe have raised concern in Europe. But there was no adequate European response to this development. Research policies had developed along different national paths and research co-operation was mainly promoted through intergovernmental agreements.

Early in the 1970s the idea of European level research policy coordination surfaced at the highest political level: *"co-ordination of national policies and the definition of projects of Community interest in the areas of science and technology"* (European Summit, October 1972). In response, Rolf Dahrendorf, European Commissioner responsible for research, suggested measures to develop a "European Science Area". The Member States reaction to this ambitious objective was lukewarm and therefore limited to setting up a new body – called Scientific and Technical Research Committee, CREST for short – to monitor national policies and explore what possibilities existed for co-operation. However, national research policies continued to develop along different paths.

During the early 1980s the Japanese challenge added an extra dimension to the European concern of loosing international competitiveness. On the proposal of the then Research Commissioner Etienne Davignon, the European Council allocated funds for joint high-tech programmes and later for a multi-annual RTD Framework Programme (see Chapter 3). The latter was the first important step to decrease differences in research efforts within the European Communities through the allocation and distribution of funds. Nevertheless, a coherent European research policy was still missing.

The Single European Act in 1986 (see Table 28) provided the basis to develop such a research policy for the first time in the history of the European Communities. Recognising this, and based on the proposal of Commissioner Dahrendorf, Research Commissioner Antonio Ruberti in 1994 suggested that European research co-operation should go beyond simply distribution of funds for co-operation. It should include coordination across national programmes. Regretfully, Member States were unwilling to listen to Ruberti and his vision sank into oblivion.

In 2000, based upon the vision of his predecessors Rolf Dahrendorf and Antonio Ruberti, Research Commissioner Philippe Busquin suggested a broad concept to develop a "European Research Area". This time EU Member States gave their support and thereby creating the conditions for a true European research policy.

The following gives the highlights of the more than fifty years of development.

After World War II, science and technology were not a major priority in the Europe of the 1940s. Europe was physically, morally and economically devastated and enervated.

Pro-European intellectuals soon realised that scientific co-operation could contribute to Europe's reconstruction, promote peaceful coexistence and help mentally and morally unite the continent. The Council of Europe (created in 1949, and an organisation independent from the later European Communities) explicitly encouraged such initiatives among its Member States. Nevertheless, the Council's role turned out to be largely symbolic and limited to debates. It played a marginal role in relation to scientific co-operation.

The first major achievement for scientific co-operation was the establishment in 1954 of the "European Organization for Nuclear Research" (CERN, located at the Franco-Swiss border near Geneva). It has become the world's largest particle physics laboratory and is a highly successful endeavour. Another important milestone was the setting-up in 1964 of the European Molecular Biology Organization (EMBO, located in Heidelberg, Germany). Its initial goals (European central molecular biology laboratory and networking to enhance interactions between European laboratories) have expanded dramatically over the decades in response to changes in molecular biology.

4 There is a rich literature on this subject. Luca Guzetti gives a rather detailed description of the history of European research until mid-1990s (cf. Guzetti 1995). Examples for more recent publications are (cf. André 2007, Banchoff 2002; Györffi 2006; Schregardus/Telkamp 2001). The most comprehensive publication about the design of EU research policy is (cf. Muldur et al. 2006).

In turn, the EEC and EURATOM Treaties primarily had economic objectives even if they both contained scientific aspects. In the EEC Treaty science was limited to agricultural research and one had to wait until the 1970s to see any move beyond this limit.

The EURATOM Treaty stipulated a European role in the area of nuclear scientific research and technology. However, conflicting national interests didn't allow EURATOM to develop to its full potential. What should have been an ambitious joint technological project ended up as a loose network of national nuclear laboratories.

However, the EURATOM Treaty provided the legal instrument and basis to establish the so-called "Join Research Centre" (JRC). Initially, four European JRC centres were established in four countries.[5]

The agreement to carry out joint research on thermonuclear fusion was yet another constructive development. The work was carried out in national laboratories in association with EURATOM and has led to major international projects such as JET and ITER.[6]

Research activities and the related fund allocation were also structured in multi-annual JRC programmes. However, by mid-1960s, budgetary restrictions and political disagreement at the highest level cast the JRC into the middle of a serious crisis.[7]

After some years, interest for European level research was rekindled. The JRC, that had weathered the storm, restructured and diversified its activities. The political leadership accepted that the JRC could be involved in non-nuclear research and therefore decisively influenced the following developments.

In 1971 a new form of European research co-operation was initiated. An intergovernmental scheme was agreed that would also include countries not belonging to the European Communities. The resulting "Scientific and Technical Co-operation" (COST) initiative was a scientifically entirely self-sufficient network. The permanent COST Committee was composed of senior officials from the countries that volunteered to participate in this initiative.[8]

By the mid-1970s it had become evident that there was a need to reorganize the European Communities' fragmented research efforts. The main triggers were internal pressure (the economic downturn) and external crisis (the oil price shock).

The European Commission responded appropriately. It placed individual research projects in a larger frame, identified areas for future research[9] and agreed on the categories[10] of research activities.

In the early 1980s a concerted effort was made to combine the so far disparate research projects in a single overall programme, called the "RTD Framework Programme" (see "EU RTD Framework Programme" in the following pages). The concept became a success and in January 2007 the 7th multi-annual RTD Framework Programmes was successfully launched (cf. CEU 2006).

In 1985, responding to the US Strategic Defense Initiative,[11] a pan-European network (i.e. beyond the framework of the European Communities) for market-oriented industrial R&D was created. Called EURE-

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[5] Two of these establishments made use of existing national-owned facilities (JRC Ispra in Italy, and High Flux Reactor in Petten, the Netherlands); the two others were built from scratch (Institute for Transuranium Elements in Karlsruhe, Germany, and Central Bureau for Nuclear Measurements in Geel, Belgium). Today, the JRC is organised in seven institutes: Institute for Reference Materials and Measurements, Institute for Transuranium Elements, Institute for Energy, Institute for the Protection and Security of the Citizen, Institute for Environment and Sustainability, Institute for Health and Consumer Protection, and Institute for Prospective Technological Studies. In addition to the above-mentioned locations in four countries, the Institute for Prospective Technological Studies is located in Seville, Spain and the JRC Headquarters is located in Brussels, Belgium.

[6] JET – Joint European Torus, the world's largest nuclear fusion research experiment, and ITER – International Tokamak Experimental Reactor, an international experimental fusion reactor.

[7] Discussion of this crisis goes beyond the objective of this paper.

[8] COST is one of the longest-running instruments supporting co-operation among scientists and researchers across Europe. Started with 15 members, COST has by now 35 member countries and enables scientists to collaborate in a wide spectrum of activities in research and technology.

[9] They included: energy, raw materials, environment, living and working conditions, and services and infrastructure.

[10] These were: (1) direct action: research carried out by JRC; (2) indirect action: research contracted to researchers / research groups in Member States; and (3) concerted action: the European Commission ensures co-ordination of research carried out in Member States.

KA, its aim was to enhance Europe's competitiveness through supporting businesses, research centres and universities to work together in joint transnational projects. The scheme became a European success story. And from its modest beginnings of 10 projects, it today comprises some 250 projects of various sizes and in different areas. Besides the European Commission, 37 countries participate in EUREKA.

In 2000, EU leaders decided to create the European Research Area (ERA). This means creating a unified area across Europe that: *(1) enables researchers to move freely and work with excellent networks and infrastructures; and (2) helps to optimise and open European, national and regional research programmes for best research*. This open research environment should help to use knowledge more effectively for social, business and policy purposes. In addition, strong links should be developed with partners around the world. In this way, "Europe benefits from the worldwide progress of knowledge, contributes to global development and takes a leading role in international initiatives to solve global issues" (cf. EC 2000).

Broadly speaking, the intellectual forming of the European research happened in three stages:

1. the suggestion of the "European Science Area" concept by Rolf Dahrendorf in 1973. Regretfully, for a long time this remained a "paper project";
2. the introduction of the multi-annual RTD Framework Programmes by Etienne Davignon during the early 1980s. Since then, it has developed to the main financing tool for EU research; and
3. the formulation of the "European Research Area, ERA" concept by Philippe Busquin in 2000 (cf. EC 2000). Since then, ERA has provided the conceptual basis for EU research.

Interestingly, not many policy analysts pay attention to the causal relationship between stages 1 and 3 above.

The three above-mentioned individuals have all been European Commissioners responsible for research at the European Commission. So far, they have left the most visible intellectual fingerprints on EU's research.

For the sake of historical correctness, reference should be made to two other Commissioners: Antonio Ruberti, who probably belonged to the class of political visionaries. Regretfully his mandate expired after only two years. Another creative European thinker was Philippo Mario Pandolfi, who recognised the importance of EC-US co-operation in the area of science and technology and intensively promoted and further developed the related high-level dialogue. (The European Research Commissioners to date are mentioned in the next Chapter).

The initiatives of the current Research Commissioner, Jan Potocnik, are promising. He attaches great importance to introducing the "Fifth Freedom" in Europe, i.e.: the free movement of knowledge (in addition to the free market in goods, services, capital and people – see Chapter 1). His aspiration is to use the potential of European research fully "by getting people, facilities and knowledge together from across the EU and beyond". In May 2007, and on his proposal, the European Commission launched a broad institutional and public debate on what should be done to create a unified and attractive ERA – in other words: how to take another step forward with the ERA concept. The ERA should thereby better fulfil the needs and expectations of the scientific community as well as business and citizens.

Fortunate for European research, influential and visionary allies in the Member States have long supported it. These include (cf. André 2007):

1. national Research Ministers as Hubert Curien (France, in office 1984-1986 and 1988-1993), Heinz Riesenhuber (Germany, 1982-1993), and currently José Mariano Gago (Portugal, 1995-1999, 1999-2002, and since 2005); and
2. eminent scientists as Pierre Auger (French physist, involved in creation of CERN), Sir John Kendrew (English biochemist and crystallographer, Nobel laureate 1962, involved in creation of EMBO), Ilya Prigogine (Russian-born naturalised Belgian physical-chemist, Nobel laureate 1977), and currently Fotis Kafatos (Greek biologist, president of the European Research Council).

All in all, European research has experienced its ups and downs. Due to budgetary constrains and political short-sightedness, research in Europe is still not optimal – it is under-funded and far from coherent. But there is light at the horizon. The ERA concept and the RTD Framework Programmes have become recognised political and scientific trajectories and driving forces for EU research. One must however keep in

[11] Strategic Defense Initiative, SDI (also called "star wars" initiative) was proposed by U.S. President Ronald Reagan in 1983. Though it was never fully developed or deployed, it provided additional support to R&D in the US.

mind that EU funded research only makes-up about 5% of the overall public and private research effort[12] in Europe.

In the opinion of the authors of this article, one of the most useful long-term effect of the EU research policy and related financing of joint projects is network building among scientists and scientific infrastructures. Be they between individual researchers or research groups across national borders or even beyond the borders of the EU. This development has greatly enriched the European research.

Beyond scientific and competitive progress, the aforementioned development has additional beneficial side effects by promoting the "European concept" of co-existence and political stability Europe. One example is the Balkan region where scientific networking promotes direct and non-political dialogue across borders of newly created countries, which may have been enemies in the recent past. Optimally, together with rising living standards, this development has the potential to contribute to promoting regional stabilisation and these countries progressive and eventual full integration into the EU.

## 2.2 EU RTD Framework Programme

Until the early 1980s, political leaders rarely treated European research kindly. Research programmes were often adopted as part of a compromise solution in conjunction with larger budgetary programmes that had greater and more immediate political visibility, e.g. the agricultural budget. This followed the usual "pork-barrelling" course.

Succeeding three European Commissioners responsible for research (Altiero Spinelli, Italian, in office 1970-1972 / Ralf Dahrendorf, German, 1973-1976 / Guido Brunner, German, 1977-1980), the pragmatic approach and political vision of Belgian Etienne Davignon (1981-1984) fundamentally changed the situation. The previous programme-by-programme (so called "salami-slice") approach was left behind. During the early 1980s Davignon provided strong leadership with the aim to formulate an all-inclusive multi-annual framework for European research.

The process was difficult and met with opposition from both inside and outside the European Commission. The latter included the scientific community, many of whose members were afraid to have their relative influence diminished. The former defended their relative independence and "small kingdoms" spread across the Commission's different Directorate Generals.

Intelligent, loyal, tactful and above all determined support by Professor Paolo Fasella, Director General for research at the Commission (Italian, in office 1981-1995) together with a small team behind him,[13] helped to ensure the initial success of Davignon's political and intellectual endeavour. After a long and difficult high-level political battle, the first Research and Technological Development (RTD) Framework Programme was eventually approved in 1984. It was considered a considerable success that opened the way for enhanced research co-operation in Europe.

However, due to internal Commission struggle and opposition, Davignon didn't succeed in fully integrating all research activities within a single framework or under the authority of a single Directorate General. No doubts, however, that during their subsequent evolution the EU research activities have been progressively more rationally structured.

To date, six successive RTD Framework Programmes (FPs) have followed the first one (see Table 29). Each of them was guided through the complex process of political adoption by six successive Research Commissioners: Karl-Heinz Narjes (German, 1985-1988), Philippo Mario Pandolfi (Italian, 1989-1992), Antonio Ruberti (Italian, 1993-1994), Edith Cresson (French, 1994-1999), Philippe Busquin (Belgian, 1999-2004) and currently Jan Potocnik (Slovenian, 2004-2009).

Broadly speaking, European Research Commissioners who helped to shape the direction of European research belonged to two groups: i) those with academic background who maintained closer links with the scientific world as Ralf Dahrendorf, Antonio Ruberti, Philippe Busquin and Jan Potocnik; and ii) those who have taken more pragmatic approach and maintained closer links with industry as Etienne Davignon, Karl-

12 In addition to the EU-level research, there are other co-operative research initiatives in Europe. Examples can be found under http://ec.europa.eu/sinapse/sinapse/index.cfm.

13 Under the leadership of Jean Pierre Contzen, assisted by Jean Gabolde. Gilbert Fayl, one of the authors of this article, was a member of this core team.

Heinz Narjes, Philippo Mario Pandolfi and Edith Cresson. To complete the picture, Altiero Spinelli and Guido Brunner were more "political animals".

By now, the FPs have become the main financial- and planning tool to implement EU research programmes and now also the ERA concept.

In general, the following main criteria guide the formulation of EU FPs:

1. Subsidiarity principle – this defines the relation between EU activities and those of its member states. Accordingly, actions are carried out at EU level only when there is a clearly identified advantage in doing so.[14]
2. Pre-competitiveness – this means that the EU supports basic research, practical applications, general development and demonstration, but not product development, industrial production and commercialisation.
3. Pre-normative research – this is research aimed at providing scientific knowledge and technical know-how on which regulations, norms and standards can be based.

To be successful with a research proposal, three issues must be clearly explained in the application: (1) the scientific excellence that is the sine-qua-non; (2) the expected impact, above all the value added; and (3) the quality of management.

Today, the EU supports large-scale co-operative projects first of all. An average EU research project includes ten participants from seven different countries.

Through the years, the EU FPs have undergone major developments. Most importantly the budget has been increased significantly (see Table 29).

Other major developments can be highlighted as follows: The content and focus of successive FPs have responded more to current European political priorities. At the same time, the rules of application and participation have become less cumbersome and more manageable. The first development took place due to increased political recognition of scientific research's societal value; the latter followed expert advice and pressure by the scientific community.

**Table 29: The European RTD Framework Programmes**

| Framework Programme No | Budget | Duration |
|---|---|---|
| FP1 | 3,750 (a) | 1984-1987 |
| FP2 | 5,396 (a) | 1987-1991 |
| FP3 | 6,600 (a) | 1990-1994 |
| FP4 | 13,200 (a) | 1994-1998 |
| FP5 | 14,960 (b) | 1998-2002 |
| FP6 | 17,500 (b | 2002-2006 |
| FP7 (c) | 53,272 (b) | 2007-2013 |

(a) Millions of European Currency Unit, ECU

(b) Millions of Euro, €. The artificial ECU was conceived in 1979 and in 1999 replaced by the real money Euro in ratio 1 to 1.

(c) Council of the European Union, 2006.

Author's archive

Environmental research, life sciences and technologies, and development of human resources through post-doctoral training in networks of centers of excellence have experienced considerable increases. Information- and communication technologies have been strengthened. Here, Member States have readjusted their national programs in favour of EU actions. In controlled thermonuclear fusion, the EU programme comprises practically all activities carried out in the Member States. On the other hand, energy research has decreased its previous dominant position. Nevertheless, renewable energy research is now a priority.

14 To this end, the German Research Minister Heinz Riesenhuber suggested a set of criteria (1983), since called the "Riesenhuber criteria".

New initiatives have been started, such as promotion of innovation and encouragement of SMEs participation in European research programmes. International co-operation has also gained more budget support.

Improved rules have reduced – albeit not eliminated – the previous heavy bureaucracy and made it more attractive to participate in EU research programmes.

In parallel, more attention has been given to ensuring coherence and synergy among all innovation and competitiveness related EU actions. To this end, concurrently with the current FP7 (see Table 29), a separate "Competitiveness and Innovation Framework Programme" has been established with a budget of € 3.62 billion for the period 2007-2013. This does not preclude the fact that there remains a serious mismatch between available resources and request for EU support. Demand from individual researchers, research institutes, universities and industry for participation in EU research programs considerably exceeds resources. While the rate of acceptance of good to very good project proposals ranges from 30 to 50 percent in most national programmes, it is only 10 to 20 percent in EU programmes.

Although the budget has increased from FP6 to the current FP7 by some 40% in real terms, all available evidence suggest that the financial means allocated to EU research are inadequate.

The prospects could certainly have been better. Of the overall EU budget of some € 862 billion[15] for the period 2007-2013, only € 53 billions have been earmarked for research. This corresponds to an average of € 7.5 billion annually. Against this figure, the overall annual research spending of the EU Member States is about € 190 billion.

By comparison, the current annual research budget of a single US federal agency, National Institute of Health, is in the order of € 23 billion (US$ 28 billion). The overall annual figure of the US is about € 250 billion and that of Japan is about € 120 billion.

Expressed in percentage of GDP, the current overall figures are around 2 in the EU[16] (Member States plus joint EU research), against around 2.6 and 3.1 in the US and Japan, respectively.

It is evident that more funds are needed for research in Europe in order to compete internationally. Both in real and absolute terms, the funds allocated to EU-level research initiatives are insufficient to match the EU's ambitious global objectives. To make matters worse, the EU is currently lagging behind its global competitors economically. The competitiveness gap is widening or at best relatively stable. Among the EU countries, economic divergence is growing. Rich Member States are getting richer compared to the average and the poor are getting poorer.

The EU's efforts to achieve economic and social convergence are in question, as is the European social model. It is, therefore, not easy to understand the Member States' "lukewarm" position to open their moneybox for EU research (cf. Fayl/Fayl von Hentaller 2007).

In spite of relatively limited funds, Member States are ready to assign to joint EU projects, EU research has clear value-added and produces useful results for European taxpayers. By now, it is generally accepted that such joint research is useful in order:

1. to pool dispersed resources (i.e. assembling critical mass, enabling "big science", leveraging private investment);
2. to integrate research (i.e. addressing pan-European challenges, coordinating national and regional policies, conducting comparative research at EU level, disseminating research more widely);
3. to promote excellence in research (i.e. supporting researchers' carriers and mobility, creating world class centres of excellence, promoting competition to increase excellence and creativity); and
4. countering market failure and addressing specific needs.

With regards to the future direction of EU research, Research Commissioner Potocnik recently stated: "The Commission is currently a funding institution for research and innovation projects. We want to change this so that we can concentrate more on policies and become like an EU research ministry, a true policymaker for the European Research Area. We want to create a specific agency next to the European Research Council to outsource management of research projects so that we can be more efficient on policies".

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15 This figure corresponds to about 1 percent of member states' overall GDP.

16 Within the EU, national research efforts are very uneven, with the Scandinavian countries on top and some of the recently joined Member States at the bottom. The discrepancy is more than a factor 10.

# 3 Renewed Political Vision for the EU

In 2000, during the EU Summit in Lisbon, European political leaders adopted an ambitious ten-year programme to revitalise growth and sustainable development across the EU. Against the background of sluggish economic growth, in this initiative the EU "set itself a new strategic goal for the next decade: to become the most competitive and dynamic knowledge-based economy in the world". (The initiative is also known as the "Lisbon Strategy" or "Lisbon Agenda" or "Lisbon Goals".)

Following on the Lisbon Strategy, in 2002 the EU leaders agreed "that overall /public and private/ spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010". In this choice the political leaders simply followed the recommendation of an expert panel[17] (cf. Majo/Guy 2000). This so called "Barcelona Target" became an essential part of the ERA (European Research Area) concept and thus an element of the Lisbon Strategy.

In 2005, it became clear that the initial objectives had been far too ambitious. Over the first five years little progress had been made. A high-level committee recommended re-focusing the Lisbon Strategy on growth and employment.[18]

Any discerning policy analyst must raise questions concerning the political soundness and validity of both the Lisbon Strategy and the Barcelona Target at the time of formulation.

Could the Lisbon Strategy have been illusory from its very inception? Could a block of 15 states (EU Members at the time when the Strategy was agreed) within 10 years transform itself to "the most competitive and dynamic knowledge-based economy in the world", while at the same time taking on board another ten new states and later two more?

Could the Barcelona Target have been illusory at its formulation? Was it realistic to expect that research spending could be significantly increased while struggling with economic recovery?[19]

One might want to consider that eight of these new member states (and later two more) and their economies had suffered for more that 40 years under the repression of the former Soviet Union.

Whatever the answer may be, the Lisbon Strategy and the Barcelona Target have started a process that can only be beneficial for the entire EU and possibly beyond. By now, the process has become more important than the initial objectives. This must be acknowledged.

Resulting from the re-focused Lisbon Strategy and the persistent reference at the highest level to the Barcelona Target, the needed dynamism seems to gradually being injected into the EU. Indeed, in December 2007 the European Commission reported that the Lisbon Strategy to boost jobs and growth in the 27 Member States was finally paying off. Economic growth had increased from 1.8% in 2005 to 3% in 2006 and employment rates reached 66% – close to the Lisbon target of 70%. However, the report also states that despite the much-improved results over the past two years, EU governments will have to focus more on "investing in people" and "unlocking SME' business potential" in the next three years if they are to cope with the competitive challenge of globalisation. The report underlined that "not all Member States were undertaking reforms with equal determination".

Obviously, the EU has still a long way to go to become "the most competitive and dynamic knowledge-based economy in the world".

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[17] The figure of 3% did not originate from any scientific consideration – it was simply a pragmatic recommendation by an expert panel: "The Panel is convinced that the percentage of GDP spent in the EU on public and private RTD should rise to at least 3**%** over the next ten years. Higher levels will be necessary without parallel efforts to avoid duplication of effort across the EU. Private sector RTD expenditure will need to be stimulated if Europe is to keep pace with its competitors. The Panel recommends the use of indirect measures such as RTD tax incentives across the EU in order to flag to the rest of the world that Europe is an attractive place to conduct RTD" (Majo/Guy 2000).

[18] The committee also underlined the need for real ownership by the Member States of the reforms. Resulting from this, most Member States have became more actively involved in the realisation of the "revised" Lisbon Agenda.

[19] Political leaders are rarely making such courageous decisions. Esko Aho, former Finnish Prime Minister (1991-1995) was a rare exception. While introducing stringent economic discipline and reduced spending across many areas, his government allocated more funds for research and education. Finland overcame a deep economic recession and today is among the best performing countries in the world.

# 4 Inherent Misapprehension

Although the Lisbon Strategy has been re-focused, its initial objective is still around and will apparently remain in the "political arena" for some time. Some have not even realised the alteration of the objective. It is almost as the Lisbon Strategy formulated in 2000 had become a doctrine of its own.

It has become "good Latin" to drop the buzzwords "most competitive knowledge-based society" at every possible opportunity. In speeches by politicians or policy related speeches by others such reference is routinely made. It is almost as if they would ask, "How are you?" Obviously, one doesn't question the meaning behind the words since everybody knows that the response is without exception just a meaningless standard phrase.

In relation to EU research policy, there are two other issues that contain a similar degree of misapprehension. One is the strong belief that increased R&D spending is a guarantee for competitive success. The "magic 3%" Barcelona Target is a clear indication for this conviction. The other is the strong desire and determination of political leaders to micro-manage public funds already prior to allocating them to research. It necessitates a reaction from policy analysts.

Each one of the three above issues contains a degree of misapprehension. The following aims to address these issues in an unbiased manner.

## 4.1 Knowledge-based Society

There is a fundamental intellectual dilemma with the expression "knowledge-based society". On the one hand, there is no clear definition of the concept. Consequently, there is no unambiguous criterion for when a society has reached this stage of development (cf. Varga 2002). On the other hand, it must be understood that "knowledge-based" means using best current knowledge. Consequently, each preceding society has by definition contained "knowledge-based" elements. This must be acknowledged. It would be total ignorance of our ancestors' achievements to disregard or reject this essential fact. Indeed, it could be a moral dilemma to do so.

Throughout history, progress has always been based on state-of-art, i.e., best current knowledge. The first stone wheel, iron tools, steam engine, electric power, etc., have represented the then "best-knowledge". They all became stepping-stones to further progress. In this respect, progressive societies have always been knowledge-based.

There are, however, a few regretful examples of the opposite. This may be particular interesting for some of the Asian readers of this publication. The most damaging has probably been the following: "[…] the decision to ground the Chinese fleet in 1433 and destroy most official records of its existence was perhaps the single greatest blunder in all of modern history. This act, whose repercussions shaped the modern world order within which we all now live, plunged China into 600 years of decline and represents the ultimate triumph of partisan politics over common sense and the national welfare" (Smith 2006).

Today's society is progressive. Biotech, IT, nanotech, etc., represent our current best-knowledge and are being used accordingly. With their help we have been able to enter into the "21st century knowledge-based society" and will continue our journey into the future. But this is not a straightforward process. Knowledge creation will continue with an unpredictable speed and often in random directions.

Individuals who have failed in traditional educational systems sometimes profoundly influence this development. A few famous examples would be: Thomas Edison was called "addled" by his teacher. Albert Einstein failed the examination that would have allowed him to study electrical engineering at the "Eidgenössische Technische Hochschule" in Zurich. Bill Gates is a university dropout. Ingvar Kamprad (IKEA founder) admitted to being dyslexic.

These and others examples have demonstrated beyond any doubt that in the 21st century – also and in spite of the use of the Internet – individuals' creativity and imagination[20] are more important than simply "memorized" knowledge and "old-style" education. Creativity and imagination in connection with communication and marketing have become the key driving forces of today's progress and competitive success. In addition, the choice of appropriate co-operative partners has become a determining factor for success.

[20] Regretfully, these attributes are not sufficiently encouraged in European educational systems.

This development has led to the current situation where the competitive focus has moved from hardware to intellectual products such as copyright, patent, trademark and design. This explains the current successful performance of comparatively small Scandinavian countries – Denmark, Finland and Sweden (cf. Dessewffy 2006).

The above considerations suggest moving away from the overused expression "knowledge-based society". The authors of this article agree with the suggestion that it is more appropriate to refer to the current situation as "creativity-based society" (cf. Howkins 2001). One would be well advised to expect that this situation would continue to evolve for the foreseeable future. In other words, the so-called "knowledge-based society" is a stage in the process of economic- and social development when products, processes and services become richer and richer in their knowledge content.

It is expected that the wealth of creativity-based societies will increasingly come from maximising knowledge content in products, processes and services. *Stricto sensu*, "knowledge-based society" will remain a moving target, and consequently remain a challenge for both present and future societies as well.

Therefore, excellent educational establishments able to produce uniquely qualified individuals, while promoting the true spirit of creativity and imaginativeness, are more important than ever before.

## 4.2 R&D Spending

Let's address the second potential misapprehension. One has to accept that there is no straightforward causal relationship between R&D spending and economic success. So far, no single approach has been universally recognized as the most effective strategy.

It is a persistent myth that simply spending more on R&D will result in enhanced economic performance and improved competitiveness. Paradoxically, spending too little will definitely harm (cf. Jaruzelski et al. 2005).

According to the "Majo expert panel" recommendation, the 3% of GDP target should be achieved with the help of simultaneous contributions by public- and private spending, the latter primarily by industry. The recommended rational figures are 1% and 2%, respectively (cf. Majo/Guy 2000). However, a predetermined percentage figure is only useful as an indicator, "not as an end in itself. Given the critical role of growth in business R&D, the market approach is the main driver" (Aho et al. 2006).

One commits a fundamental flaw when interpreting the recommendation of Majo panel in a simplistic way. A country's R&D-need is influenced by its technology- and industrial specialisation and other societal- and economic factors. To illustrate: a country specialised in services (finance, tourism, etc) is expected to have a lower R&D intensity than countries focusing on IT, biotechnologies, etc. (cf. Pottelsberghe 2008).

Generally, in Europe private R&D spending is of particular concern as it is stagnating. In contrast, EU companies' investments are continually on the increase in the US.

One may surmise that, with regards to R&D spending, the EU as a whole is lagging behind the US and Japan, while China is well on the way to catch up with the EU.

The wise "decoding" of the recommended 3% budget figure can be of use in order to guide policy-making at both national and EU level. It helps to draw attention to the need for adequate research funding and may even trigger political discussion at the highest level on related fund allocation. That is how the EU's 3% "Barcelona Target" should be interpreted.

R&D spending must be seen in the right context. It has been repeatedly demonstrated that it is the overall research and innovation effort that may lead to competitive advantage. Therefore, in addition to adequate public and private funds and their efficient use, such efforts must fulfill a number of additional conditions. Notably, they must include excellent scientists, well developed S&T infrastructure, appropriate supporting measures for scientists and their intellectual output, established links with industry, etc. They must further be able to recognise opportunities and need for innovation in time.

A system with the above features will have high innovation potential. It will be able to introduce and efficiently use current and/or new solutions in a timely manner to improve the performance of an organisation, process or commercial offering (product or service). This will lead to competitive advantage.

Innovation happens in a complex environment. Firstly, the need of industry, public administrations (central, regional, local) and civil society actors and individual members generate the pull for innovation. Secondly, the offerings of *h*igher *e*ducation *e*stablishments and research institutions (achievements of scientific and technological conquest) provide the push for innovation. Thirdly, the demand for new and innovative products and services comes first of all from individual customers. The customer has far too often been forgotten in the innovation policy debate.

Taking all factors into account, larger economies may be able to afford to spend a smaller proportion of their budget on R&D than smaller economies.

Comparative small Scandinavian countries are often mentioned as best-practice examples, where high R&D spending has led to top positions in international competitiveness rankings. In isolation however, this is a simplistic statement. It disregards the fact that funds are not solely responsible for competitiveness achievements. These countries have traditionally always had excellent higher education systems, well developed infrastructures, etc.

Nevertheless, from a tactical point of view of the scientific community the “3% approach” is helpful. Through easily understandable examples, it is possible to exercise pressure on political leaders for more funds. But not developing the other critical factors in parallel – even worse, disregarding them – will certainly be counterproductive in the longer term.

Simply to claim that a country with high R&D spending will become more competitive than another with lower spending (both expressed in percentage of their GDP) is far fetched. Equally pointless is any exercise that looks at “divergence from the 3% Barcelona Target” in isolation. The authors of this article caution against such a simplistic “linear” approach.[21] Yet, simple economic indicators fascinate many policy analysts.[22]

In the EU, only the largest economies – such as Germany, France and the UK – can afford to support expensive research on their own. Smaller economies would not be able to individually mobilize the necessary resources and critical mass to compete with the big European ones even less with the US, Japan or China.

Individually, smaller economies can be successful in selected targeted areas. As a consequence, joint European R&D initiatives (such as EU RTD Framework Programmes, COST, European Science Foundation projects, etc.) are relatively more important for small economies than big ones. Nevertheless, all EU Member States – both large and small ones – doubtlessly profit from joint European initiatives. Disappointingly, funds allocated to these initiatives are comparatively small.

The EU’s Barcelona Target of 3% of GDP spending on R&D must be seen in the context of the above. It is necessary but insufficient on its own. It should not be considered an absolute objective in its own right – neither as a magic solution for raising competitiveness.

One must keep in mind that the figure of 3% has no scientific foundation. It is a pragmatic estimation (with other words, “qualified guesstimate”) by an expert group (cf. Majó/Guy 2000). Admittedly, it has achieved its aim and succeeded in mobilising attention on R&D funding. Indeed, the progress towards the 3% target from a lower figure can be considered as an expression for the ability and readiness to modernise the national science policy in question.

## 4.3 Political Guidance

It is naturally also necessary to address the third issue that may give raise to misapprehension in connection with the European research policy, i.e. the some time micro-management of research funding by political leaders. This is certainly a highly controversial issue between scientists and political leaders.

Rationally, the essential principles of conducting high-quality research with public funds are straightforward: (1) find the best qualified researchers; (2) provide them with adequate funds; and (3) let them do

[21] A high-level expert group has recently formulated a set of authorative recommendations that needs to be followed in order to enhance Europe’s innovation capacity (cf. Aho et al. 2006).

[22] A more comprehensive novel approach is currently under development in a joint effort by the OECD and other international bodies. The aim is to measure how societies are changing in areas that affect citizens’ quality of life. It goes beyond conventional economic indicators such as employment, productivity, purchasing power, etc., and look at such factors as education, health and the environment (cf. OECD 2007).

what they think represents the best use of their intelligence and time, while respecting fundamental ethical principles (cf. Bromley 1994; Bush 1945).

Underlying this approach is the concept of societal investment rather than political procurement. In an ideal world, this approach may best serve the long-term interest of society. Unfortunately, in the real world the process is complex rather than straightforward. Obtaining public funds for research happens in a "battle-field". The two main actors enter with different presumptions and objectives.

On the one hand, researchers possess a certain degree of "political naivety". They are ready to ignore constraints that are dictated by political realities, such as limited public funds. In turn, politicians often demonstrate "scientific ignorance" due to their inadequate scientific background. In addition, politicians operate with a different time horizon – the date of their mandate's expiration hangs above their heads like a Damocles sword.

Only even-handed negotiation between researchers and decision makers can ensure best use of taxpayers' money. To this end, both sides must make an effort to better understand and respect the other's manoeuvring options. Moreover, in order to generate "science for society", relevant civil society actors must become equal partners.

It is particularly important that political leaders will take a view of longer time horizons. They must also understand that it is not possible to force human creativity into a straitjacket. Their desire to only invest public money in "safe projects" is false. Much worse, in the long-term it is dangerous and counterproductive for society. Europe's main competitor, the US has undeniably demonstrated that putting money into new, risky projects – based perhaps only on hypothetical ideas – will in the long-run be profitable economically as well as being good for society.

In Europe, the 7th EU RTD Framework Programme and the newly created European Research Council[23] are certainly steps in the right direction.

Another significant positive development is that, in order to better meet the challenges of globalisation, EU Member States have decided to establish a European Institute of Innovation and Technology (EIT). Its role is to "stimulate European innovation and help turn innovative idea", thus "contributing to the targets of the Lisbon strategy for the creation of growth and jobs". EIT's activities are to be based on excellence-driven networks of higher education institutions, research organisations and businesses, coordinated by a governing board whose members are selected on the basis of strict criteria. Its headquarters were decided to be in Budapest, Hungary (cf. CEU 2008).

In spite of all the laudable development, the current EU research effort is still insufficient. In the opinion of many policy analysts and – of course – scientists, considerably more funds are needed in Europe to support high-risk research. Unless this happens, the best European scientists will continue to look for more optimal research conditions outside Europe. So far, they are looking first of all at the USA but soon it may be Asia, including China – the "rising star".

As a constructive warning to our political leaders: they must understand that major scientific conquest often results from trial-and-failure approaches. Failure must be accepted as an unavoidable "ingredient" of research (cf. Andersson 2007).

In dealing with public money, political guidance is helpful. But there must be room for failure. Excellent scientists should be encouraged to conduct risky projects. A positive side-effect may even be more European Nobel Laureates.

In conclusion, recent improvements in the area of EU research are promising and appreciated by the scientific community. But there is room for improvement.

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23 Established early 2006, the European Research Council is the first pan-European funding body to support investigator-driven frontier research. Its aim is to stimulate scientific excellence. Scientists should go beyond established frontiers of knowledge and boundaries of discipline. It complements other funding schemes in Europe. The founding is from the 7th EU RTD Framework Programme.

# 5 Understanding Meaning Behind Words

As every other policy of the EU, its research policy has been developed –and is still developing– in a highly complex political environment. It results from lengthy and often difficult negotiations, including at the highest political level.

There are a multitude of interacting forces involving a variety of personalities and institutions from many countries, and not least political leaders. They range from civil service and bureaucratic levels through policy-making right up to the highest political decision-making. Furthermore, there are pressures dictated by interest groups, be they local, national or beyond, that could outweigh arguments, supported by scientific advice. Well-prepared proposals for political decisions may be fully or partly altered due to last minute "pork-barreling" by political leaders.

Understandably, EU research policy may therefore not most optimally serve the interest of each and every researchers and research group in the Member States. But it is the best compromise that can be achieved at a given time at EU-level. As such, its aspiration is to serve the general interest of the European scientific community and society as a whole.

The same can be said about the related EU RTD Framework Programmes. They represent the optimal achievable solutions at the time of their approval by political leaders. They are formulated and decided on in a complex and evolving political environment where the global ambitions of the EU are not at a standstill.

There have been ups and downs, many compromises, and difficult negotiations. Individual national interests have collided with each other and with EU interests.

In this environment the parties have developed their own "lingua Franca" with specific wordings and meaning behind. Insiders understand it. Outsiders may find it less obvious and easily decodable.

This paper has hopefully helped to shed some light on certain issues that contain a degree of misapprehension. The European Union *has* a research policy.

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# Part II: On History and Theory of Prospective Technology Studies

# Prospective Technology Analysis for EU Level Governance of Research and Technological Development. Challenges, Problems and Possible Solutions

*Michael Rader*

## 1 Introduction

Prospective technology analysis activities have a history reaching back at least several decades: Herbert George (H. G.) Wells pointed out the need for professors of foresight in a BBC broadcast as early as November 19, 1933.[1] Recent interest in most countries of the world has been aroused by foresight, initially at the national level. Many countries have in the past decade hosted national foresight exercises, covering a broad range of scientific, technological, and increasingly social, topics. Countries that conduct national foresight studies also pursue other, similar, activities – some labelled foresight and others bearing names such as technology forecasting or technology assessment.

The label given to an activity does not permit any automatic conclusions on goals, approaches and methods. Two activities bearing different labels may have greater similarities with respect to process and methods than two activities bearing the same label, but taking place in a different context with different primary or secondary addressees. However, they address a range of technology-related subjects, draw on a common toolbox of methods, and intend to inform decision-making of one kind or another.

## 2 Types of Prospective Technology Analysis

It is possible to distinguish several alternative analytical forms of prospective technology analyses (this section is based mainly on Rader/Porter 2006):

- *Technology intelligence* – monitoring information on technological development;
- *Technology foresight* – studies to identify possible technology-related futures;
- *Technology forecasting* – attempts to predict the actual progress of technology;
- *Technology roadmapping* – the identification of milestones along a specific trajectory of technological development;
- *Technology assessment* – the comprehensive assessment of opportunities and risks of technologies and their application.

Such a list is not without its problems, since activities of certain kinds, like technology forecasting or technology roadmapping, can form part of another kind of study, such as technology foresight or technology assessment.

Despite the lack of distinct definitions and an amount of interchangeability of labels, there are certain essential features that affect types and methods:

- Apart from some limited scope technology forecasting, such prospective activities *seldom aim to predict "the" future*, instead exploring possible futures of varying degrees of likelihood. Predictions on the availability of technology (technology forecasting,) are quite frequently made and used in broader activities, but it is rather more difficult to predict applications and diffusion of technology, so these topics are themselves frequently the subject of more exploratory analyses (c.f. Medina Vasquez/Sánchez 2006).
- In some cases, a *specific future is regarded as desirable* and an aim is to identify measures which could lead from the present state of affairs to this desirable future ("backcasting"). "Visions" like those developed by the German "Futur" activity or the NBIC initiative of the National Science Foundation and the US Department of Commerce serve a similar purpose, usually in a narrower sphere. *Roadmapping* pursues similar aims by defining milestones in the development of a technology and its applications.
- *Technology assessment* originally emerged with the aim of contributing to the balance of power between the legislative and executive branches of government, but has increasingly moved towards

[1] This was pointed out by Miles/Keenan 2003, p. 41.

- providing knowledge suitable for *actively shaping* technology. This has led to the emergence of such concepts as participatory technology assessment, constructive technology assessment, discursive TA, consensus conferences, etc.
- *Foresight* usually covers a broad range of technologies, increasingly also including the societal context of technology applications. The best known early technology foresight studies were on so-called "critical" technologies regarded as key to future economic development. While there has been an aversion to anything suggesting centralised national S&T planning in the US and, therefore, no national foresight, most foresight in other countries has been commissioned by national governments. In countries with a tradition of centralised planning, there is a danger that foresight will be misunderstood as a new tool of central planning (c.f. Böhle/Rader 2003, p. 7).
- An important factor driving foresight activities has been *globalisation* and the attendant *shift in the role of nation states*. The *identification of promising areas* of science, research and technology likely to add to the attractiveness of certain locations for job creation has led, on the one hand, to stressing the network building functions of foresight – creating dialogues among the various actors and stakeholders with an interest in technology – and on the other hand – to a shift from the level of the nation state to more local levels, where regions or cities compete as attractive locations for research and its economic spin-offs.
- In all, foresight has *shifted its focus* away from the state to a broader ranger of stakeholders, including industry, resulting to some extent in a "convergence" of US prospective technology analysis emphases, such as competitive technical intelligence and roadmapping, with those of Europe.
- Contrary to some popular perceptions, such as the distinction between TA, foresight and technology forecasting made by the ESTO network (cf. Rader 2001a, p. 4, but revised in Tübke et al. 2001, e.g., p. III), technology assessment can be focused either on a specific technology or group of technologies *(technology-driven TA)*, or on technology-related problems *(problem-driven TA)*. Since TA is frequently dealing with complex technological innovation issues beyond the control of the state, the results of TA studies are increasingly addressed to coalitions between the state and societal actors, including experts, political and industrial decision makers, and stakeholders of all kinds (cf. Petermann/Coenen 1999).
- A major *distinction between foresight and technology assessment* was formerly the *range of technology* covered by exercises: the best known technology foresights address a broad range of technologies while technology assessments are narrowly focused. However, more recently *foresight i*n countries which have conducted broader exercises has *tended to focus more on specific cases*. The Futur process in Germany is organised starting very broadly and narrowing the field as a result of consultation until it produces a limited number of "guiding visions" ("Leitvisionen"), intended to provide the framework for state S&T endeavours. After two cycles of classical foresight, the United Kingdom foresight programme was reshaped to focus on such specific topics as coastal protection and cognitive systems. The activities under these headings are difficult to distinguish from activities labelled "technology assessment" elsewhere.
- A further distinguishing feature between foresight and technology assessment is the *time horizon*, which is typically 30 or more years for foresight and rather shorter for technology assessment. The first Swedish foresight (cf. STF 2000) project pointed out the "Zeitgeist"-Problem related to this aspect: the tendency to be captive to "the spirit of the times" and to assume that tomorrow's problems and visions will be very much the same as today's. This implies that the persons involved in the foresight tend to examine rather shorter ranged futures than hoped. An additional problem in this respect is that progress in some areas of technology is much faster than in others, so that foresight here is more difficult than in areas of slow movement.

## 3 The Use of Prospective Technology Analysis for RTD Governance

Most EU member countries and many other countries and regions have performed large-scale *foresight* studies of various types. An important subset of these are studies aiming at the identification of *critical technologies*, often using the Delphi method.

The main aim of national and regional foresights is to inform agenda-setting in research, science and technology policy. National level studies have been conducted in most of the EU Member States, the bulk up to about 2005 but some, like Luxembourg or the Slovak Republic, more recently. Additionally, foresight methods have been used for regions or municipalities, so that recent activities have covered smaller territories. During this phase, there have been a number of what PREST researchers have called "fully fledged foresight", the "networking of key agents of change and sources of knowledge, around the development of strategic visions based on anticipatory intelligence" (Miles/Keenan 2003, p. 42).

The Czech national foresight study actually had the aim of developing a draft national research and development programme, but most others have aimed at less direct impact, i.e. pointing out science and technology related options and their likely impact, to inform decision-making. The methods employed for this purpose cover a broad range and most foresight studies are not limited to a single method. The primary objective is frequently to achieve a consensus among stakeholders on priorities for science and technology policy in the hope of optimising the return on the investment of public funds in research and technological development. Secondary benefits include the creation of networks among groupings of stakeholders which in some cases continue to exist after the foresight activities themselves have been completed.

The concept of comprehensive, future-oriented *technology assessment* was popularised by the now defunct U.S. Office of Technology Assessment which worked for the US Congress. Presently, the term "technology assessment" is most closely associated with *activities for parliaments*, although it is also used for activities not directed in parliaments, mainly in German-speaking countries. Several national and regional parliaments in Europe have their own semi-permanent capacities for TA, some even created after the demise of the OTA, and most recently the European Parliament has signed a framework contract with a group of these parliamentary TA units to provide services to its own panel with responsibility for TA, STOA (Scientific Technological Options Assessment).[2]

According to the political context, the purposes of such activities can vary greatly. The critical technologies lists in the US were intended to help orient American R&D investment toward areas of economic importance. This is achieved mainly via *general awareness*, not explicit mandate setting. Elsewhere, studies focused on critical technologies have at best been used to inform national or regional decision-making on priorities although there has seldom been a direct, visible relationship.

Except in extreme cases where foresight has been connected strongly with agenda-setting (e.g. in the Czech Republic or Ireland), it is difficult to gauge success in terms of influence on the process. In several cases it is possible to assume that foresight has been regarded as useful by its clients, since these have either set up institutional arrangements for continuous foresight activities (e.g. OPTI in Spain, the Foresight Directorate in the UK) or commissioned new foresight (Sweden, Germany).

In the case of parliamentary Technology Assessment, there is in many cases a direct link between the topics covered by TA studies and ongoing legislation. A crucial factor for the success and destiny of institutions serving parliaments in this way is timeliness: one reason given for ceasing to fund OTA was that the studies did not fit well with the pacing of legislative activities. The link between the legislative process and TA activities is possibly a factor working against the success of these activities. A more promising approach might be that of "early warning" and creating understanding of science and technology: the studies for the STOA panel of the European Parliament have no direct link with ongoing legislation processes, but serve to pinpoint critical aspects of technologies and their application which might require the attention of legislators at some later point in time. Even here, there is the possibility that research might be overtaken by ongoing developments, such as those we are currently witnessing in the energy sector.

The TAMI project has identified a non-exhaustive list of 21 specific roles that Technology Assessment has played in individual projects. Correspondingly, the project develops a typology of impacts, related to three issue dimensions: technological/scientific, societal, political/policy oriented, and three impact or goal dimensions: Increasing Knowledge, Forming attitudes or opinions, Initialising actions. The typology is actually the result of decomposing TA projects into individual steps, each with a distinct role and target. It is suggested that the *"introduction of the concept of roles reveals that TA plays more roles and has more impact than usually appreciated"* (Decker/Ladikas 2004, p. 19; italics in original). The selected methods result from the issues which are the subject of the studies and from the roles the project has to play, i.e. the individual roles/goals into which it can be decomposed.

We can distinguish several roles for such activities in governance. An important distinction is whether they are designed to be used for specific on-going decision-making or to provide a basis for decision-making at some time in the future (early warning function). A second dimension is the kind of decision, i.e., regulatory (laws, regulations, standards etc.) or financial (on spending of budgets). There is furthermore a differ-

2 Cf. http://www.itas.fzk.de/eng/etag/etag.htm.

ence in the type of output: recommendations versus collection of facts, identification of stakeholders and positions and possibly a discussion of available options.

# 4 European Level Activities

The Framework programmes of the European Commission have tended to use different labels for very similar activities: the fifth Framework Programme included measures for Technology Assessment, the sixth addressed Foresight with a special unit assigned responsibility for activities, which included some originally labelled and funded as “technology assessment”. Among the major activities of the unit has been the setting up of a “foresight knowledge sharing platform”, the European Foresight Monitoring Network,[3] co-ordinated by TNO.

The closest Europe has ever come to a fully-fledged comprehensive foresight project covering the whole European Union was the IPTS “Futures” project which ran from mid 1998 until early 2000. While it involved almost 200 experts as panel members, it made no attempt at the involvement of citizens or even representatives of major stakeholders. Apparently, the Commission President’s Cellule de Prospective will in the near future embark on a study focussing on the year 2020 (personal communication, November 2007).

In a more narrow area, the IPTS-led foresight project FISTERA (Foresight on Information Science Technologies in the European Research Area) and its successor EPIS06 (European Perspectives on the Information Society – the 06 stands for the year the project started, there are tentative plans for an EPIS08 or 09), were foresight projects specifically on information and communications technology or, in the case of FISTERA more precisely on a specific vision of future societal development, namely the information society. The ultimate aim for these activities is to inform the Directorate General responsible for support of research and development in the area (DG INFSO) in a timely fashion to develop the framework programme or the specific programmes for information and communication technologies. The author has also been involved in a recent specific support action for the foresight unit in Directorate General Research which is intended to inform agenda setting for the social sciences and humanities in connection with convergent technologies, most prominently nanotechnology, biotechnology, information technology and the cognitive sciences.

A second focus will be on the work labelled as technology assessment currently being performed by a group of parliamentary technology assessment organisations using the collective name European Technology Assessment Group (ETAG[4]). The “client” is the STOA (Scientific Technological Options Assessment) panel of the European Parliament.

# 5 Informing Decision-Making on S&T Priorities

The FISTERA project started in September 2002 as a Thematic Network under the Fifth Framework Programme. It was set up to contribute to building the European Research Area in Information Society Technology (IST) research. Its objective was “to contribute to a common vision and approach towards the Information Society in an enlarged Europe in 2010. It aimed to create a pan-European platform on foresight in Information Society Technologies (IST), involving a wide range of key EU and national IST policy makers and players (cf. Compañó et al. 2006, p. 7).

The FISTERA project employed multiple methods including analysis of existing foresight reports from Europe and beyond for their findings on information society technologies, the setting up and maintenance of a database on information and communication technologies and possible trajectories for their future development, an identification of important players in research and development to position Europe relative to its competitors on the global scale, a series of workshops, initially on a regional basis and later on an interest group basis, plus an online Delphi exercise seeking to involve experts from Europe and beyond.

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[3] Cf. http://www.efmn.info.

[4] At this writing, the full members of the group are the Danish Board of Technology, the Flemish Institute of Science and Technology Assessment, the Parliamentary Office of Science and Technology (UK) and the Rathenau Instituut of the Royal Dutch Academy of Sciences, led an coordinated by ITAS, which is the “mother” institution of the German Bundestag’s Office of Technology Assessment.

A final synthesis report with the main findings from FISTERA was published in 2007, so here we will only concern ourselves with policy related aspects.

The Delphi survey revealed that the majority of respondents saw national governments and firms in IST as the two "key players" for improving the development and deployment of IST applications in nearly all areas. European institutions were expected particularly to contribute to the improvement of applications for social welfare and public services; cultural diversity; transport and work organisation. The actors in the field expected the EU to undertake social and institutional innovations and to focus especially on reducing the "digital divide". Additionally, the EU was expected to contribute towards the improvement of the communications infrastructure, to support new and improved applications of information and communications technologies and to create training and awareness programmes.

Some of the recommendations derived from FISTERA research are targeted at setting priorities, while others are aimed at stimulating generic competencies in order to address specific weaknesses due to existing specialisation patterns, since the long-term development of the competence base seemed to matter more than short-term technology programmes. In this way, it was hoped to be better prepared to make the best of opportunities created by unexpected technological disruptions.

Despite the internationalisation of R&D in IST, the results of FISTERA confirmed the important role played by very large players. Europe-based firms are well represented in the world league of IST, but there is a lack of the large and medium-sized players. Thus, another recommendation was for RTD policy to also keep the second and third tier of IST firms and research organisations in focus.

The EPIS06 project pursued a roughly similar approach to FISTERA, its predecessor, but its activities related to developments in ICT in general were rather less elaborate – the FISTERA database was succeeded by a monitoring activity compiled in a "Monitoring Synthesis Report" – and a novel feature was a so-called real-time Delphi, which no longer has separate rounds but allows participating experts to have feedback and change their opinions at any time. Another major difference to FISTERA was that EPIS focused its attention mainly on a single application area rather than all information society technologies, in EPIS06 this focus was on creative content.

# 6 Informing Decision-Makers to Provide Early Warning

The European Parliament's Scientific Technological Options Assessment (STOA) Panel celebrated its 20th anniversary with an exhibition on the Parliament's premises in Strasbourg on June 19, 2007.[5] Since 2005, STOA has had a framework contract with a group of technology assessment institutions working for national or regional parliaments in Europe.[6] This arrangement is leading to the production of a series of reports, based mainly on a review of existing literature and the consultation of experts. In particular the former European Commissioner for Science, Philippe Busquin, in his function as chairman of the panel, has noted several times that such reports would also be of interest to national parliaments, especially those without their own capacities for technology assessment.

Prior to the framework contract with ETAG, STOA had commissioned individual reports from universities or other institutions and the new arrangement had been set up to provide more effective advice to parliamentarians.

The STOA panel is composed of delegates from the permanent committees of the European Parliament, such as those for Industry, Research and Energy, the Environment, Employment or Agriculture. Each of these committees can also commission specific work needed to inform ongoing legislation, so that the work for the STOA panel has more of an "early warning" function by examining new or emerging technologies for any aspects that might require future attention from the parliament, be it for priority-setting for future framework programmes of the European Commission, be it in the shape of legislation.

As stated before, the reports produced under the framework contract are based mainly on reviews of existing literature and expert interviews or workshops. More ambitious methods are largely precluded due to

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5 Cf. http://www.europarl.europa.eu/stoa/events/workshop/2007_experience/default_en.htm, accessed on July 17, 2007.

6 Cf. also footnote 2; the group is known as The European Technology Assessment Group (ETAG), cf. http://www.itas.fzk.de/eng/etag/etag.htm.

costs: the annual budget of the panel is in the region of half a million Euros, which is less than a quarter of the budget of the German Parliament's TAB, on which STOA is to an extent modelled.

# 7 Lessons from European Level Work

## 7.1 Foresight

Experience from FISTERA shows that few findings from national foresight can be transferred to the European level, or even from one European country to the next. The choice of the best method for an own foresight study depends on the national context and cannot be copied without considering factors of context, such as responsibilities for science and education, the organisation of research etc.

The European dimension usually plays a minor role in foresight considerations targeted at the national or regional levels. An aggregation of the findings from national and foresights reveals differences within Europe rather than common interests. Thus there is a genuine need for regular pan-European monitoring and foresight studies to provide a basis to help overcome this apparent fragmentation and draw attention to the potential of European cooperation and collaboration in endeavours to overcome challenges usually exceeding the capacities of the individual member states.

Another argument in favour of foresight efforts on specific technologies is the degree of granularity at the level of individual technologies: the more "universal" technology foresight studies at the national level, like most of those analysed by FISTERA, attempt to develop rather broader strategies at the expense of detail. Thus more specialised studies are required to devise strategies for a more specific area of technology like IST.

Creating a *European* vision cannot be based on the sum of national visions. Although the making use of results of the national foresight exercises is a necessary pre-condition, an active participation of the stakeholders with a view beyond their national interests is necessary. Creating a European dialogue would be a suitable platform towards constructing this vision. FISTERA's approach was face to face dialogues with approximately 600 Persons, who participated in one of the 11 roadshow workshops in the Member States and 10 thematic meetings at the European level. More than 150 persons from 20 countries participated the final conference. This approach does not, however, sufficiently respond to the challenge of achieving representative European participation.

Online Delphis, while a relatively effective method of involving geographically dispersed stakeholders, have also some clear limitations. First, to motivate online participation requires a lot of effort. The response rate is low (on average below around 10%). There is some resistance against responding online, and stimulation of potential respondents with email is difficult, in particular if the sender is an unfamiliar institution. It is thus advisable to involve local organisations with good reputations to underline the seriousness of the survey. Secondly, the quality of an online Delphi is not comparable to a face-to-face exercise. Online animation of the process cannot replace the spontaneity resulting from human interaction.

The original intention was for a two-way relationship between the users and producers of the technology database set up for FISTERA: about 400 persons used this service per month[7] but very few actively contributed to its development or population.

FISTERA found that a key element to success was the participation of decision makers as an integral part of the foresight process and not only as the mere receivers of the end products. In the course of the project, FISTERA succeeded in attracting a high number of decision makers from industry and public institutions,[8] however, only a fraction of them participated regularly in events. Considering that on one hand decision makers have many commitments, and that on the other success depends on their active participation in the foresight process, practitioners have to take this into account when designing the process and the planning.

[7] The database receives about 5,000 Hits per month of which 400 visitors interrogated the database for longer time periods (> 5 minutes) and FISTERA considered them "users".

[8] FISTERA has contributed to numerous advisory boards of the European Commission *and* in the FISTERA conference, 30% of the participants were regional, national or supra-national policy makers, and 30% were industrialists.

The FISTERA Report argues that priority-setting needs to be built on clear and transparent arguments, especially when there is a need to justify and legitimise public policy intervention. Among the building blocks deployed to fulfil this condition are:

- Identification of the emerging scientific-technological trajectories outlining the emerging future opportunities space.
- Identification of socio-economic needs and requirements to which technology applications are expected to contribute in the future.
- Identification of strengths and weaknesses of the European research and innovation system, also in terms of industrial structures.
- The global developments and strategies with which European actors will have to deal, like for instance internationalisation of R&D and the emergence of new strong players.
- Vision and orientation with respect to the kind of desirable (information) society.

An approach to interpret the findings on these building blocks in order to translate them into priorities and to justify public policy action at national and/or European level, aiming to realise research and innovation that take into account the S&T opportunities as well as the user needs and institutional settings for enabling their interaction.

Priority-setting requires interaction with and participation of actors and stakeholders, due to the often controversial nature of these issues and the recurrent lack of hard data. Participative approaches can support action more directly by informing and mobilising actors, and even contributing to the building of communities, to realise the priorities identified. Experience in FISTERA underlined a need to intensify the level of direct interaction with and involvement of the key actors in charge of priority-setting.

FISTERA made a considerable effort to share experiences of lessons learned on foresight and, indeed, its methodology influenced foresight exercises in several countries including Romania, Hungary, Austria, Poland and Colombia. Even so, the project was primarily intended to generate sound and topical policy-relevant results, rather than to push the methodological frontier of foresight forward.

EPIS06 employed a largely similar approach to FISTERA including participation via workshops and the Delphi method. The approach envisaged for the successor project foresees a more interactive approach for the technology monitoring activity, based to an extent to experience with online journals, such as epso-n, a newsletter established for discussion on electronic payment systems,[9] or the INDICARE Monitor used in a project on Consumer Issues in Digital Rights Management Systems.[10]

With regard to participation a pan-European project on brain science, the “Meeting of Minds” project, employed a method it termed “European Citizens’ Deliberation”.[11] This attempts to unite two possible routes towards citizen participation:

- The development of adapted versions of existing methods, such as citizens’ conferences or consensus conferences.
- The simultaneous implementation of national participative activities, the results of which are compared and synthesised for the European level.

In the case of the Meeting of Minds project, there was a pan-European citizens’ panel which received input from parallel national assessments. Use of such methods is obviously elaborate and only advisable if there is a genuine and urgent public dimension to the issue in hand. In most other cases, it is probably sufficient to set up expert panels with sufficiently broad expertise and national coverage.

## 7.2 Technology Assessment for the Parliament

In mid 2007, there was a discussion within the STOA panel on experience with its framework contract. On its own function for the parliament, the panel noted that science is vital to economic growth in the EU and therefore a necessary area of interest for MEPs. The quality of the reports was generally regarded as high, but it was noted that they had little or no impact. Although the reports were relevant for MEP work, the committees who originally proposed projects made little use of the projects and workshops which are a

9 Cf. http://www.itas.fzk.de/deu/Projekt/pez/epso.htm.
10 Cf. http://www.indicare.org/tiki-page.php?pageName=IndicareMonitor.
11 Cf. http://www.meetingmindseurope.org/europe_default_site.aspx?SGREF=14&CREF=6688.

regular feature of each project are attended by a small minority of MEPs. The panel also noted that the studies did not engage MEPs, citizens or stakeholders sufficiently, and also, that once completed, the reports did not reach all their target groups.

A major problem was that MEPs were time-challenged with insufficient time to read STOA studies. There was thus a need to build political interest, in marketing terms, “buzz” about the product. MEPs’ attention could best be captured by stakeholders and citizens alerting them to the significance of STOA projects.

Another suggestion to increase impact of studies was to approach the committees directly with both the final reports and offers for presentations. As noted before, STOA reports are not linked with ongoing legislation, so that it is important to insure that they are considered when a topic does find its way onto the parliamentary agenda.

The impact of projects could also be enhanced by better engagement of civil society and stakeholders through their reinforced attendance of and participation in workshops to discuss findings from studies. The panel also thought that efforts should be made to disseminate reports into the member states, in particular those without their own resources for technology assessment.

A criticism of the workshops concerned the style of presentation by the experts, described as “all too often … dry, long, boring, confusing or … ironically too basic”. While individual aspects might play some role here, there is also the fundamental question of requirements and specifications for such presentations which could be provided to help make them more interesting. Additionally, creative manners of presentation could be tested. There was also the question whether fully-blown, elaborate workshops should not be reserved for issues which are timely, stimulating wide parliamentary interest.

A major problem of detaching projects from the legislative agenda is that either the issue in hand is viewed as too remote to attract much interest from parliamentarians or that projects could easily be overtaken by events, so that results of research actually arrived too late to have any impact on parliamentary debate. Thus, the STOA panel recognised a need to better align its projects with the agenda of the parliament, the trick being to be sufficiently in advance to have sufficient time for the study before its subject reemerged on the parliamentary agenda.

There is already a network for parliamentary technology assessment institutions in Europe, known as EPTA (European Parliamentary Technology Assessment). A number of parliaments have their own scientific units to perform studies while others have more ad-hoc arrangements. Not all national parliaments in the EU have any institutionalised technology assessment activity, although, as the STOA panel notes, science is vital to growth and thus an area of essential interest to parliamentarians.

Thus, the STOA panel, and in particular its chairman as a past European Commissioner for Research, has set its sights firmly on the European dimension:

- As far as possible, replication of work done by researchers elsewhere should be avoided. An option is to have presentations in parliament by groups of researchers working at the national level in order to identify gaps or specific issues for the European level. This is also an option for national parliaments.
- Joint projects by several organisations could make more efficient use of resources, enable a wider scope and eventually lead to a common European or EU agenda on TA. Joint European projects could be larger in scale and capture the interest of media coverage more than a project on a national or regional level.
- Such joint projects would require advance planning by the parliaments concerned, but would enable a division of labour on specific tasks with the understanding that results of research would be shared and that marketing and promotion could be done jointly.
- This applies particularly to large scale issues of joint interest to all EU member states, such as climate change, ICT infrastructures, energy and transportation.
- More effort could be devoted to aspects of presentation of results. Responsibility for content could be shared among the participating research groups, which could also give presentations in the various parliaments. The quality of reports could also be improved for this reason.
- Another medium-range possibility is to have joint meetings between the bodies of the parliaments responsible for the projects concerned.

# 8 Conclusions

Problems of prospective technology analysis for European level governance can be divided into those which apply to the type of analysis in general and those which are only relevant at the European level.

The major *generic problems* concern participation of stakeholders and the *effective use of the results of studies*. In studies seeking to achieve a consensus or to reflect the range of positions and interests in a matter, adequate participation is an essential element for the success of the endeavour. The most effective method of participation is probably the workshop in which the various stakeholders are able to put forward and exchange their views on contested issues, but increasingly, and particularly for geographically dispersed actors, on-line methods such as discussion fora and online Delphi surveys are of growing attractiveness. Beside the approaches already mentioned, online newsletters[12] or focus groups[13] are interesting alternatives.

The effective use of the results of projects depends on such factors as involvement of the client and attractiveness, timely and compelling presentation of results. In the case of the European Parliament, involvement of a parliamentary "supervisor" does add to commitment, although this could be improved by involving representatives of other target groups of the activity, including other parliamentary bodies, and – with the necessary distance – also major stakeholders.

At the European level, with 27 member states in the European Union alone, representativeness of participation is a major issue, the more so, if there is any need to capture a cross-section of European positions and opinions. Online methods are certainly the most promising approach to ensure a sufficiently large number of participants, but even this requires careful planning, as is indicated by experience in the FISTERA project. Beyond this, the European Citizens' Deliberation Method employed by the "Meeting of Minds" project (cf. Steyaert/Vandensande 2007) is promising through the combination of national level participation providing input for European level debate. On the debit side, this requires a great deal of effort and is probably only feasible for extremely important topics: to achieve effective participation requires participants to be able to converse in their own language, making interpreters mandatory (see the example of the European Parliament).

The effective use of studies has been a sensitive point ever since scientists have been writing reports produced by policy-makers. It has always been difficult to gauge the impact of researchers' findings on decisions, even if they have been specifically commissioned to inform policy-making.

STOA work is directed towards the first two goals identified by the TAMI project (cf. Decker/Ladikas 2004) increasing knowledge – in this case of parliamentarians – and forming attitudes and opinions. To a lesser extent, it is oriented towards initialising actions in the future. Most foresight work targets all three, with an emphasis mainly on forming attitudes and opinions and initialising actions.

In all cases, it is important to involve the intended recipients and users of study results. In the case of the parliament, a start has been made by nominating so-called parliamentary supervisors for each project. Effective use of this arrangement requires involvement of the supervisor throughout the project to achieve his or her commitment to disseminate results among other parliamentarians or beyond. For studies whose main addressee is the administration of science and research policy, it is correspondingly important to achieve the involvement and commitment of "project officers" and others whose work is the target of the findings of projects.

In the specific case of foresight, an important effect is the creation of networks and relationships which can endure beyond the termination of the project. While face-to-face meetings are an enormous benefit for achieving this goal, on-line methods can also make a major contribution. This applies both to surveys and to methods designed to stimulate debate, such as interactive on-line journals and fora.

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# Foresight-type Programme in Ukraine in 2005-2006. Brief Historical Overview of Foresight-type Studies in Ukraine

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## 1 Introduction

Ukraine has a long history of foresight-type studies. The very first attempts to prepare normative forecasts of S&T and economic development in Ukraine could be associated with the establishment of the centrally-planning system. Since late the 1970s, so-called Complex Programs of S&T Progress for Twenty Year Periods have been started to be prepared every five years along with "usual" five-year plans. These programs were oriented on strategic issues and possible effects of S&T development, not on short-term economic goals. At least 1500 key specialists from different research institutes took part in these programs. The panel method has been used to reach consensus on different issues. In contrast with the five-year plans, it was possible to generate different scenarios within the program. This helped to better understand various outcomes and problems of the future. But "the future" assumed the existence of the status-quo in political and social spheres: communist regime could not be changed and large-scale market reforms could not be introduced. These programs were parts of the similar All-Union program that had to co-ordinate development within the Soviet Union. At the end of the Soviet period, another 15-year forecast with special attention to the territorial deployment of productive forces and the distribution of R&D in different regions was introduced.

In 1980s and early 1990s various ministries, Academy of Sciences of the Ukraine and even large companies in the military-industrial complex started to prepare their own long-term technological forecasts to define their technological policies. Some of them used Delphi-type procedures. Methodology of forecasting graph and computer software for these forecasts were developed by the Cybernetics Institute of the Ukrainian Academy of Sciences. Unfortunately, in the context of fundamental social and economic changes in the second half of 1980s almost all these forecasts had no serious impact on development in Ukraine.

It would be also important to mention that in 1998-1999 the Cabinet of Ministries of Ukraine initiated a project to prepare so-called "Indicative Plan of S&T and Economic development till 2005". The preparation of this plan was coordinated by the Ministry of S&T. The panel method (with creation of several subcommissions on different S&T spheres) has been used. About 300 specialists have been involved in the preparation of the Plan. Two joint sessions have been organized at the end of the one-year project. Unfortunately, again, after changes in the government, the draft of the plan has been forgotten (despite it was published and disseminated between different state ministries and agencies). It is worth to mention that in Ukraine "pure forecasts", based on time series, have not been used widely. That is why from the very beginning Ukrainian future studies involved a number of experts and they were closer to the foresight methodology, than to the formal methods of statistical forecasting. At the same time, term "forecasting" is used widely among Ukrainian experts, and sometimes we will use it as synonymous to "foresight".

## 2 Methodological Background and Organization of Work on Foresight-type Program

Every five years, the Ukrainian parliament establishes several main S&T priorities and the government starts dozens of technologically-oriented programs. It is widely recognized that priorities are formulated in a very broad sense, the programs are not well-designed and they have not enough financial resources to be undertaken. Time horizons of the specific programs (and projects) are usually short (1-3 years), who will be possible consumers of the results, and what will be the economic parameters of innovative products are not clear. That is why the government has decided to supplement existing mechanisms by a new foresight-type program.

The full title of the program is the National program of "Foresight of S&T and innovation development". This program has been approved by the Cabinet of Ministry of Ukraine in August 2004, but it started in 2005, when the state provided some financial resources for it. Initially, the government had plans to provide 800 thousand Hryvna Ukrainian (approximately 145 thousand Euros according to the official exchange rate) for two years but the real amount was more modest – around 425 thousand Hryvna (approximately 77 thousand Euros). The Ministry for Education and Science and the National Academy of Sciences of Ukraine were the key organizers of the Program.

The key objective of the Ukrainian national foresight-type program was to form priorities in S&T and innovation spheres for long (15-20 years) and medium (3-5 years) term perspectives and to determine the most promising areas for R&D, which could receive state financial support. The second main goal of the program is to create background for a permanent system of state-sponsored foresight studies in the country.

In fact, the program had four main tasks:

- to elaborate the basic and alternative variants of S&T and innovation development of the country;
- to form a list of the most prospective technologies and innovations, which will create opportunities for opening new external markets;
- to form a list of so-called critical technologies, which will have exceptional importance for the stable development of the national economy and for the national security;
- to prepare recommendations for the Ukrainian government on how to use effectively R&D results, financed by the state, and to create the background for the permanent system of foresight-type studies in the country (cf. NASU 2006).

Ministry for Education and Science (MES) of Ukraine, which "substituted" the Ministry of S&T after its merger with the Ministry of Education in early 2000s, was responsible for the distribution of money between participants of the program and the general logistics. The National Academy of Sciences of Ukraine was responsible for the content of the foresight studies.

Elements of the Delphi technique and the panel method have been used in the program. At the first stage, Scientific Council of the program has been formed. It includes around 30 prominent Ukrainian scientists and top state officials. Two research institutes (one – from the Academy and the second – from the MES) were nominated as base organizations, which were responsible for the technical side of program realization.

After broad consultations, fifteen thematic groups of scientists and other specialists were formed:

1. actual problems of state support of basic sciences and its infrastructure;
2. biotechnologies;
3. means and technologies for medical treatment of widespread diseases;
4. telecommunication, information technologies and resources; optical electronics and new computing technologies;
5. energy saving, non-traditional and renewable energy sources, problems of hydrogen energy utilization;
6. advanced technologies of agricultural production and food industry;
7. technologies of metal connections and treatment of metals and alloys, new composite materials;
8. lasers and ionization technologies; nanotechnologies, functional and instrumental materials;
9. perspective chemical materials and technologies;
10. protection of environment and sustainable development;
11. macroeconomic tendencies, demography and human potential;
12. applied aspects of sciences about earth;
13. innovation in construction and architecture;
14. innovation in transportation systems;
15. space technologies and "dual-use" technologies in the national economy.

Every group of experts consisted of from 25-40 specialists from different research institutes, universities or leading industrial companies, usually from different cities of Ukraine. Special questionnaires were prepared and distributed among these experts in two-stage Delphi procedure. On the second stage about 20% of experts were replaced by other specialists as a result of the analysis of the initial responses. The third round of surveys was finished in October –November, 2006. The third round provided recommendations on how to improve the situation with S&T and innovation in Ukraine.

Every previous stage (round) of Delphi was ended with special conferences and round tables of experts and invited "external" specialists, who discussed the key results of the program. Publications on the results of the studies were prepared and widely distributed among specialists within the country. In fact, everyone could express his or her opinion on the key findings of the program. It is worth to mention that with the assistance of British Council, British specialists with experience in Foresight program took part in methodological seminars and conferences, which were organized within the program in 2005-2006.

However, from a methodological point of view, the procedures of knowledge generalization, expert selection were not formalized, which opened the way for consideration of opinion of a limited number of specialists, and as a result, to one-sided conclusions in some cases. Even questionnaires were prepared without detailed studies of the similar experience in developed countries. That is why future projections could not be considered as very reliable, although it was possible to avoid absolutely unrealistic estimates that dominated forecasts and the evaluation of the situation in different sectors of Ukrainian science in the early 1990s (cf. Prognoz 1991).

At the same time, analysis of the S&T potential in the Program report contains a realistic picture of the situation in Ukrainian S&T and points out problems Ukrainian science faces in the mid-2000s.

## 3 Results of Analysis of the R&D Sector

The years of transition have demonstrated that the state had insufficient material resources to preserve science in such conditions that it was during the years of the Soviet regime. Substantial reduction of R&D funding occurred during the period of market transformation, including cutting down funds for financing new purchases of research equipment, while science was deprived of prestige, and the status of scientists has eroded. These changes resulted in gradual reduction in the number of researchers and collapse of many branch (industrial) research institutes. Many scientists of middle age left their academic establishments and industry institutes and swapped their activities for more profitable ones, some of them emigrated. This caused deepening of an age gap between different groups of scientists, which was accompanied by a considerable shortage of 30-40 year old specialists - the most active part in terms of creative capacities. An age crisis in science will be hanging over Ukraine in the years to come. Alongside senior generations leaving active involvement in science, the shortage of skilled specialists will be even more evident. By implementing urgent measures the processes of age unbalance of personnel can be halted, however the problem is complicated by the fact that it is very difficult to resume research activities after several years break because of the very specific nature of this activity. In particular, measures undertaken by the government to increase payments to research fellows are incapable of changing the situation radically, although the crisis will be less acute.

The current level of relative expenditures established in Ukraine is obviously incapable to ensure efficient research processes because the funds will barely suffice for relatively low wages and utility payments. Ukraine spends much less per researcher per year than EU countries, including new member-states, and less than even India or South Africa.

On the other hand, some relative indicators of financial support of R&D in Ukraine look more or less acceptable. From official data state R&D expenditures within the GDP of Ukraine stayed level, which was slightly lower than 1% of GDP in 2006 and 2007, and higher than 1% in 2000-2005. Formally, the share of the budgetary funding of R&D goes down constantly. It is worth to mention that the Ukrainian Parliament endorsed by law the share of R&D expenditures in budget expenditures (1.7%) in the mid-1990s, but this decision has been never implemented.

Yet the alternative computations testify that the percentage is considerably lower. In many cases, R&D expenditures include some expenses that have nothing in common with conducting research and development (cf. Bulkin 2002). In addition, existing classifications facilitate the implementation of “double calculations”, especially when it concerns carrying out research projects with subcontractors.

Assignations on research and development in constant currency of 1991 decreased substantially, and now they are less than 60% of the level of Soviet times. Several important issues are thus to be addressed.

First of all, R&D expenditures were dropping down over the whole 1990s, except for 1998 when the expenditures grew slightly (in the fixed prices for 1991) and resumed slowly climbing in 2000-2007.

Secondly, the rates of R&D decrease in the 1990s exceeded the rates that the Ukrainian GDP was decreasing. The problem was aggregated by fact that the expenses of R&D organizations for electricity, heating and other utility payments grew at higher rates than other costs. They grew to up 30% of all expenses, while the wage share in R&D expenditures exceeded 50% in some sectors. At the same time expenses on upgrading equipment, purchase new instruments and reagents did not exceed 3%-5%.

Thirdly, one more important issue has to be mentioned: the number of science and technology personnel was shrinking slower than general R&D expenditures, i.e., the “human load” that would burden the money remaining in R&D was ever-growing. To some extent, it was offset by means of internal redistribution of funds and the growing share of salaries in general R&D expenditures. Yet substantial degradation of the material and technical component of the science and technology potential along with the declining capacities for experiments and development was the price for such "social adaptation" policy. Depreciation of the material basis for conducting research took place at a slower pace than research personnel was reducing. Such processes in the nearest future would ultimately convert a considerable part of the research establishment in the fashion of welfare institutions: engineers and researchers would have relatively few modern pieces of equipment to conduct scientific research.

Establishment of favourable conditions for development and use of creative potential of researchers is the most appropriate and shortest way to introduce positive changes in S&T and innovation areas. Owing to conditions that would comply with world standards, scientists can be preserved and at least a part of those who went abroad can be encouraged to return. According to our calculations, Ukraine spends approximately 25,000 US$ per researcher per year that is much lower than in developed and even some developing countries.

In accordance with the Budget law, science and technology expenditures are secured expenditure items of the State Budget of Ukraine. Scientific research is funded from the budget pursuant to the basic and programme-oriented procedures. Basic funding is made available to carry out:

- fundamental scientific research;
- research in the most essential for the state directions, including national security and defense R&D;
- development of S&T infrastructure;
- preservation of scientific objects of national property;
- research personnel training.

The list of scientific institutions and higher educational establishments to which the budgetary funding is made available to carry out S&T activities is approved by the Cabinet of Ministers of Ukraine.

Budgetary expenditures to carry out R&D and innovation activities dropped down lately both because of a gap between the rates of growth of expenditures by such budget items and the nominal rates of GDP growth and due to the deficient implementation of government obligations in the science and technology area as well.

Structural and evolutional features of R&D funding in Ukraine, and specifically implementing R&D, the parts of public and private sector virtually did not change over 1996-2006: R&D area remains in the state's care for the most part, and very few companies have created their own R&D units. Only in 2000-2006 had the first signs of recovery in medium-tech sectors been observed. Economic growth has stimulated some R&D, but for a number of companies R&D is reduced to adjustment of foreign products to the local market. In the early period, the new government has reduced substantially budgets of almost all key technology-oriented programs, including programs in civil aviation and military spheres, where Ukraine had some preconditions for effective development (cf. Yegorov et. al 2006).

The role of the state in R&D could be asserted by the fact that the bulk of financial resources are distributed among state-owned companies and organizations: the state-owned companies and research organizations are responsible for three quarters of Ukrainian R&D. Bearing in mind that in 1995 the share of the state was 84%, it could be possible to conclude that the role of other sectors is growing in recent years.

Over two thirds of the general amount of S&T funding in Ukraine are traditionally concentrated in four economically developed regions. The overall amount of science and technology funding in a capital region (Kiev and Kiev oblast) decreased insignificantly both in absolute and relative terms and remained the largest as against other regions in 2003-2007. The amount totalled to 40% of the general amount of funds nationwide. Kharkiv oblast possesses the second place with 17% of total R&D expenses, followed by Dnepropetrovsk with 9% and Donetsk with 6%. These last three regions have especially strong positions in technical sciences, related to machine-building sector. In recent years they could even increase their shares in the state's R&D expenses, while the poorest Western Ukrainian regions are falling further behind the leaders.

Ukrainian classification of scientific disciplines slightly differs from the international standards. So, at the highest level of classification you will not find Medicine, it is on the second level within Natural sciences, other differences are of smaller importance. Distribution of funding according to scientific disciplines still has typical features of the Soviet system. Technical (engineering) sciences still dominate but in recent years the highest growth rates have been demonstrated by economics, legal sciences and political sciences. It is also clear that Ukraine has relatively weak positions in biological sciences, pharmacy and medicine. This is also confirmed by the very low SCI of the Ukrainian specialists who are working in these disciplines. Key reason for this is the low demand from corresponding industries and high emigration of specialists in these areas.

The bulk of money is distributed through contracts. The state provide money to the institutes of the National Academy of Sciences and Universities some branch institutes for doing research on selected areas without any competition. The only Foundation that uses competitive procedures is the State Foundation for Fundamental Sciences, but it distributes les than 1% of all budget money, which is much lower than in neighbouring Russia and former socialist countries. There is a need to increase substantially the role of the Foundation in financing Ukrainian R&D by raising its share to at least 4-5% of the state R&D budget.

Thus, the academic sector and higher education sector are funded from the state budget mainly, whereas R&D organizations associated with industry sectors are funded through the orders (contracts) from customers.

Specialists, who are involved in foresight program suggest that the government could increase financial support for S&T, as well as the private sector, but it is not evident it would be enough to reach the level, which neighbouring Eastern European countries will have.

Considerable erosion of personnel potential of Ukrainian science occurred in the 1990s. Overall employment in R&D was reduced by almost two thirds, and taking into account the intense growth of fictitious employment and impossibility to conduct R&D because of lack of money for equipment and materials, actual cutback of labour spending in science, the figure was even bigger.

There is a trend in Ukraine towards reduction of total employment in science and technology. In particular, it is possible to stress that a major reduction of employment occurred in the first half of the 1990s, however trends in the R&D employment remain negative even in conditions of economic growth over 1999-2007.

Data on the dynamics for the same period of the number of researchers and engineers carrying out R&D in Ukraine are even more indicative. The cutback of such category of specialists slows down more visibly, yet the processes of relative stabilization conceal some other negative trends, in particular, deterioration of personnel age structure which has been mentioned earlier.

On the whole, it can be stated that a downward trend in the overall R&D employment is stable. At the same time the rates of reduction of a number of specialists conducting research and development somewhat decreased in recent years (from 16% in 1991-1992 to 1% in 2001-2006), yet it must not bring about optimism, since other factors are increasingly facilitating for degradation of scientific potential of Ukraine.

A complicated social situation for specialists in Ukrainian R&D largely determines a fashion whereby main responsibilities are combined with other activities that, unfortunately, are not research or training activities. A number of scientists combining their jobs doubled in 2002 in comparison with 1991 (grew by more than 100%) and amounted to almost 70 thousand specialists. In our view, it attests to the crisis in existing institutional structures of Ukrainian science, within which the state fails to organise comprehensive research process and to provide decent salaries for those who are involved in R&D.

Average age of doctors of science employed in R&D grew in 1990s years by one year on average every 2-3 years and in 2006, it was 61.5 years, i.e., higher than the “retirement ceiling”. Obviously, subsequent aging of doctors of science will inevitable lead to a decline of creative potential of this category of scientists. Similar trend can also be seen in the dynamics of age parameters of candidates of science. But it is even worse. The problem is that Candidates of sciences leave research institutes more actively. At the moment, only about one quarter of all Ukrainian Candidates of sciences are working in R&D, others are involved in other types of activities.

Age crisis in science will be hanging over Ukraine in the years to come. It is practically impossible to dodge it, yet the consequences can be somewhat alleviated. Alongside senior generations leaving active involvement with science, the shortage of skilled specialists in science will be more vivid. By inculcating urgent measures the processes of age unbalance of personnel structure can be halted, however the problem is complicated by the circumstance that it is very difficult to resume to research activities after several years break because of the very specific nature of this activity.

Concerning distribution of scientists by different disciplines, the representatives of engineering sciences maintain their dominance in Ukraine: more than 50% of overall R&D employment. The situation still remains almost the same compared with 1991 when such specialists made up nearly 74%. However, the changes are obvious and most likely, the percentage of representatives of engineering sciences will keep falling down.

As statistical data indicate, three groups of institutes are best positioned in terms of decent labour conditions and relatively high salaries.

- Industry institutes with stable links with large businesses in Ukraine and Russia. For example, Gazprom almost entirely funds activity of several project-design bureaus in the gas industry.
- Institutes that set the mutually beneficial relationships with scientific establishments in developed countries, and whose employees regularly obtain considerable grants for conducting research, travel abroad and so forth. This group contains some institutes of biological profile of the NAS of Ukraine, Institute of Mathematics.
- Institutes of sociological profile that were contracted to conduct various studies and take part in political campaigns in some manner. Average wages in the institutes of sociological profile are about twice as high as in other institutes.

It is worthwhile to note that expectations of vigorous expansion of graduate studies programmes thus involving youth into scientific areas were not justified. Increase of the number of defended dissertations is clearly inconsistent with the growth of the number of graduate students. In addition, many young scientists after defending dissertations choose careers outside research or emigrate.

Loses from emigration are already significant in Ukraine. The estimates are based on the assumption, that 9-11% of all emigrants are former employees of the R&D sector. About 1% of all emigrants are specialists with scientific degrees. Officially, about two- three hundred scientists emigrate from Ukraine every year. These figures do not appear to be very high. But in some sectors they are particularly significant. As sociological surveys show, shares of specialists in mathematics, physics and biology among emigrants from the institutes of the research institutes are extremely high (cf. Egorov 2005). This means that for some specific areas losses were critical. In many cases official statistics does not reflect the real processes that take place.

It would not be right to mention "pure" emigration only. There are other forms of migration of highly-qualified specialists from key scientific institutions. So, according to official information, approximately seven hundred specialists left the Ukrainian Academy of Sciences only in 1989-1992 for long-term business visits and training. More than 1/3 of them have not returned, although they are still considered as members of the Ukrainian research institutes.

A growing number of scientists use "unofficial" (that are not under the control of administrators of the research institutes) channels to go to the West. They participate in training programmes, receive stipends from foundations, etc., without even consulting with the heads of their institutions. Such behaviour could not have been imagined in the former Soviet Union.

A lot of researchers do not cut their ties with the home country and they even preserve Ukrainian passports, but they do not return to Ukraine, rather they continue to work abroad on a permanent basis. This can be explained by a number of reasons, namely tax regulations, visa rules and so on. In any case, these data show that emigration has changed from its traditional forms and this phenomenon has yet to be studied.

Speaking in general, in recent years three new tendencies appeared in the pattern of emigration.

*First*, emigration became "professional" rather than "ethnic". There was a strong evidence of outflow of specialists irrespective of nationality from Ukraine in late 1990s/beginning of 2000s. For the first time Ukrainians began to receive permission to emigrate to developed countries under the classification of specialists, rather than as refugees or family members.

*Second*, the will to emigrate grew stronger among young scientists. Many young people are trying to pass exams to enter Western Universities or to receive long-term work contracts in the West.

*Third*, there has been a change of direction in emigration. A remarkable number of specialists left Ukraine for Russia in 1990s – mainly from the military-industrial complex and the nuclear energy industry. The difference in salary between specialists in Russia and Ukraine doing the same job in these areas exceeded several times, that provoked emigration. In the military-industrial complex emigration is not on such a massive scale, but Ukraine is losing its best specialists in the most important areas of R&D, possessing knowledge urgently needed now for the Russian military-industrial complex. A vivid example is V. Utkin, predecessor of S. Korolev and the heir of M. Yangel in the position of Director of "Yuzhny mashinostroitelny zavod" (Southern Machine-Building Factory) – the biggest missile-building complex of the former USSR.

However, it is important to stress that the problem of internal relocation of educated persons is more serious than the problem of emigration. Low wages and lack of orders for intellectual products have led to an outflow of millions of educated people to other sectors of the national economy, primarily to private businesses and the state administrations. This process could not be considered as purely negative, because the effectiveness of the whole economy could rise as a result. The pressure on state budget is eased and preconditions for old colleagues from R&D institutions are usually maintained. The diffusion of former researchers from R&D into other sectors could bring positive results at the present stage of economic recovery. Unfortunately, the absolute majority of former scientists have undertaken relatively simple work that does not require the scientific qualifications they have.

The main threat to the intellectual potential of Ukraine comes from hidden emigration. This type of emigration is based on a combination of formal maintenance of workplace in a scientific institute or design bureau while pursuing other work that is not connected with R&D. This is a widespread practice in modern Ukraine. Many specialists formally associated with R&D institutions or production enterprises spend the bulk of their time on outside activities and mainly in the retail trade. The key reason for this situation is the above-mentioned lack of demand from the side of industry. But actually, the state supports this kind of activity indirectly by establishing low level of salaries, by compelling people to take long unpaid leaves or by delays in salary payments.

As to the state of R&D infrastructure, the situation is far from optimistic. In 2007 the average annual price of capital assets in science and technology area in the state exceeded more than 20 billion UAH. But these figures do not reveal the real situation in the research institutes. The bulk of the price is associated with the buildings of the institutes and the land they have in prestigious districts of large cities. Only two percent of research equipment of Ukrainian science and technology establishments meets world standards. This makes effective research almost impossible in many areas and decreases competitiveness of scientific results of Ukrainian scientists.

Obtaining professional information to science and technology establishments continues to be a big problem. Ever since 1991, a situation with acquisition from leading scientific libraries remained extremely disappointing. Only a limited number of foreign titles was available thanks to exchange programs or courtesy of foreign partners. Number of scientific titles decreased, which is especially true for engineering and natural sciences. Not every scientific establishment, especially in regions, has the access to broadband Internet.

## 4 National Innovation System Formation and Ability of R&D Sector to Address Emerging RTD Priority Areas

The national innovation system in Ukraine is weak, as the authorities do not pay serious attention to the stimulation of development of the hi-tech sectors. Creation of conditions for growth of high tech enterprises is the key for the future of the national economy. If the government will establish a system, in which traditional sectors of the economy will not have artificial privileges, it would be possible to shift resources to innovation and R&D.

As to particular research areas, traditionally, Ukrainian scientists have relatively strong positions in material sciences, physics and some technical disciplines. Here, Ukrainian experts look forward with restrained optimism. It seems that in some scientific fields S&T development will preserve dynamics and it is possible to expect interesting applied results, as, for example, in welding technologies. It is worth to note that problems of energy saving, utilization of alternative sources of energy and upgrading of energy generating system have received the highest marks for their importance. Bearing in mind existing potential and experience, there are high chances that these problems will be studied and (partially) solved successfully.

On the other hand, the gap between Ukraine and the developed countries in such areas, as biotechnology, genetics, electronics, nanotechnologies, health care methods will grow, despite the fact that these research areas have received high marks for their importance from experts and Ukrainian scientists have promising results in some narrow sub-fields of these disciplines.[1]

Interdisciplinary researches, such as physical and chemical biology, sensors and environmental studies were mentioned as important directions of development.

Traditionally, Ukrainian experts put high value on space research and technologies. But now and in the observed future the country could not conduct this research without intense international co-operation. The accent will be made on practical aspects, including observation of agricultural lands, telecommunications and weather predictions.

Development of the aviation industry, including introduction of several new planes, such as the AN-70 and modern modifications of AN-225, are under serious threat after the worsening relations with Russia. At least several joint important projects have been halted, and the prospects of other projects are not clear.

The above mentioned problems reduce the ability of the Ukrainian scientific community to solve urgent problems that Ukraine faces and to conduct regular research. In principle, the country has enough specialists to do research in different areas, their qualifications are relevant to the tasks they have to solve. On the other hand, erosion of the scientific potential is evident. The quality of education in natural sciences is going down, the possibilities to do research at the international level are shrinking, and the problem of aging and the substitution of retired specialists is growing (cf. Yatskiv et al. 2006).

This does not mean the R&D system will not be reformed, and the competitive principles of funds distribution have to be implemented. It is important to mention that the indicators of scientific performance in Ukraine are largely neglected. Experts predominantly analyse the dynamics of resource indicators of science, primarily the state of funding and personnel endowment instead of indicators of effectiveness of scientific activity. Efforts of authorities are also focused on adjusting values of resource indicators. The economic effect from the use of R&D results is adjourned and, as a rule, it is not limited to one enterprise or a company. R&D results can be used in various economy sectors, whilst some effects certainly cannot be correctly displayed in monetary form. For this very reason to estimate effectiveness of scientific activity informal methods were applied, specifically peer review. Furthermore, to describe the effectiveness of science two groups of numerical indicators could be used – publication activity and patent and licensing activities.

Indicators of publication activity such as the number of publications and level of quotation remain one of the few acknowledged quantitative characteristics of effectiveness of scientific performance, especially in the fundamental science area.

The total number of scientific publications in Ukraine in 1991-2006 had an unwavering upward trend regardless substantial cutback of R&D employment. An increase in print output was remarkable in 1991-2006.

In addition, the aggregate amount of scientific publications grew rapidly, the number of publications increasing on specific subjects in some regions of Ukraine, are noteworthy. Thus, it is essential to note that this process occurred against the background of continuous underfunding of research activity: in recent years, a lion's share of R&D allocations was spent not on scientific experiments but on personnel salaries and operational expenses.

One of the most important reasons for such a state of affairs is virtually nonexistent control over the results of statistical information processing as regards publication activity.

It can be noted that scanty 20-25% of the articles inventoried by domestic Ukrainian statistics were registered by world databases in the early 1990s. Data for the last several years were not compiled by the State Committee for Statistics of Ukraine. On the other hand, the number of relatively low quality publications, which are not considered internationally, has continued to grow. Differences in the dynamics of these indicators are clear. Decreasing number of publications in rated magazines of the ISI database to some degree was brought about to some extent by the exclusion of several Ukrainian magazines from it in 1990-1999. This happened not because there was no control over the number of publications from the side of the research community and the State Committee of Statistics. Only eight Ukrainian magazines were included

1 Cf. http://foresight.nas.gov.ua.

into the SCI database (all magazines are published by the National Academy of Sciences) in 1999, whilst there were thirteen magazines in 1990. In 2007, this number had shrunk to five.

The number of papers published by Ukrainian researchers is growing, however owing primarily to publications rated rather low according to international standards. This is the only one example, which shows that the Ukrainian system of evaluation of R&D results needs serious revision.

## 5 Conclusions and Policy Implications

Ukrainian foresight-type program shows that the country still has scientific potential in a number of areas. At least, Ukrainian specialists could provide qualified expertise of the importance of different research results and determine perspectives of S&T and innovation in key research areas. At the same time, it is evident that the country's research system continues to lag behind the international standards of research, despite that it has world-class results in some research fields. S&T policy has to be better connected with the implementation of economic reforms. It is becoming critical for Ukraine in present conditions. The most urgent objectives at the present stage of economic development are as follows:

- development of R&D organizations and enhancing R&D management, in particular, development of new organizations and economic forms of integration of science and production;
- mastering of advanced management expertise by Ukrainian experts and their further dissemination nationwide;
- improvement of industrial structure and acceleration of socio-economic development of the regions;
- active implementation of R&D results and advanced technologies into different sectors of the national economy;
- further development of S&T co-operation with other countries, especially with the EU and neighbouring states (cf. NASU 2007).

There is no guarantee that the country can solve successfully a number of problems it faces at the moment, but the clear orientation on integration into the EU opens the way for effective modernization of the national S&T system and its utilization in the interests of the Ukrainian society and the European Community.

In today's economic conditions of the Ukraine, the role of scientific and innovation activities are to be growing. In particular, it is necessary to augment the role of scientific foresight in all areas of science, social growth and national economy development. Although foresight is an important scientific instrument to make correct selection of social and economic growth, it has been neglected for years. Now the urgent need for foresight studies is evident for a number of scientists, industrialists and officials. In particular, outlines and priorities of scientific research economic policy, aimed at long-term economic growth, are to be identified by means of foresight. There are strong plans to conduct nation-wide foresight studies in Ukraine on a regular basis.

Unfortunately, the government could not provide any financial resources for foresight-type research in 2007. Only in the second half of 2008 a new round of researching started. Methodological foundations have changed substantially, organizers have plans to involve representatives of business circles and government officials more actively to the process of foresight preparations.

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# Cooperation with Middle and Eastern European Countries in the Field of Technology Assessment – Results and Experiences. A Short Overview

*Gerhard Banse*

## 1 The Background

In the middle of the 90's we began research cooperation with colleagues especially in the Czech Republic, Hungary, the Russian Federation, Poland and Slovak Republic. The research fields are Technology Assessment (TA), ethics of science and technology, sustainable development and knowledge based information society (cf., e.g., Banse 1998, 2007; Banse et al. 2000).[1]

Important aims of these "go east" activities – mostly by ITAS – are:

- to "watch" institutional and content-related activities in the field of interdisciplinary technology and environmental research (monitoring) in order to create starting points for cooperation opportunities;
- bi- and multilateral activities should be carried out to concentrate and combine different conceptual as well as methodological knowledge in the fields of technology risk assessment and environmental research.

This mainly concerns

- research on theoretical and methodical aspects of technology assessment, risk assessment and environmental research under the influence of ethical interrelations;
- knowledge transfer in the field of education (related to both that of natural, technological and economic scientists and of social and human scientists).

The background is the "non-knowledge" of this situation especially in Germany, but in other Western European countries as well: Middle and Eastern Europe was a "terra incognito"! It was an "unknown land" – regarding the knowledge there of interdisciplinary technology and environmental research, the situation of the environment, restructuring in industry and agriculture, trans-formations in the field of science, or approaches in technology policy.

But in the past years a lot has changed: improved situation regarding information, better understanding of the respective problem situation, joint activities. With the transformation processes of the last fifteen to twenty years in these countries the opportunities in the field of interdisciplinary technology and environmental studies have improved.

Some remarks in this direction to the past and to the present are in order. Starting point for me was a project of the European Academy Bad Neuenahr-Ahrweiler, Germany, entitled "Technology Assessment und Ethics of Science in Central and Eastern European Countries" (Czech Republic, Hungary, Poland, Slovak Republic), 1997/1999. The aim was a state-of-the-art report on the situation in these countries:[2]

- topics;
- institutions;
- persons;
- activities;

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[1] In this time there were differences in terminological and conceptual respects. In Germany, as in France or Great Britain, quite heterogeneous scientific and political, methodological and ethical, participative as well as elitist, institutionalized as well as „free" concepts (which all certainly somehow have something in common), are concealed behind the abbreviation „TA" – if it is used at all. On the other hand, there are many and varied designations – in the German language area alone – from „Technology Impact Evaluation" via „Estimation" or „Judgement of Technological Impact" to „Technology Impact Assessment". Can one expect conceptual or terminological „assimilation" from people in the nations of East Central and Eastern Europe, who haven't had the chance to gain enough experience with the „Discussion Culture" prevalent there? For this reason, we find in those countries some activities which in fact are TA, but are not called „TA", as well as some which are called „TA", but aren't.

[2] A short overview of this project in English is given in Banse 2000.

- forms, etc.

Before this project started there were two interesting activities:

1. in October 7-9, 1991, in Prague took place the conference "Technology assessment and its role in processes of society transformation in Central and Eastern European countries" – and one of the organizers was ITAS (cf. Proceedings 1992);
2. 1994-1995 was the project "Transformation of the Central and East European Science Systems", lead by Renate Mayntz, Uwe Schimank and Peter Weingart (cf. Mayntz et al. 1995; cf. also Mayntz et al. 1998; Provazník 1996).

The background for both activities was the following situation: With the process of transformation in East Central and East European states in the 1990s, the chances for progress in the fields of TA and the (practical) ethics of science and technology have, on the one hand, improved, because TA and the ethics of science as a means of advising politicians are – scientifically – much more widely recognized than was formerly the case, are supported by society, and are politically accepted; on the other hand, worsened, because the basic industrial as well as the financial conditions and the situation on the labor market in the individual nations show in general a negative trend. For this reason, the (financial) means for considerations which could – in the sense of political advice as decision support in social questions – pave the way for mechanization, are probably quite limited (see also the articles on the background theme „Science and Technology amid Change in Eastern Europe" in: Technology 1993).

But these two activities by ITAS and by Renate Mayntz and colleagues were without sustainable effects!

My first steps showed:

1. There were different activities in research and teaching (e.q.: in Poland by Lech W. Zacher and Andrzej Kiepas, in Czech Republic by Ladislav Tondl, in Hungary by Imre Hronszky; cf. Hronszky/Tibor 1994; Kiepas 1987, 1995; Tondl 1992; Zacher 1984, 1996).[3]
2. Many of these activities haven't the name "technology assessment", but "philosophy of technology", "science and technology studies", "problems of scientific-technological revolution" or "technological prognostic".
3. The solutions and activities were mostly in a specific national manner (based on the national culture, history, political traditions, etc.).
4. That means that the "transfer" of solutions, which were established under other national conditions (eq. in the institutional direction) mostly had no chance of realization (see the "destiny" of TA in Hungary or of the Prague Institute of Advanced Science [PIAS] in the Czech Republic[4]). This was influenced by the national strategy of development – in science, technology, education.
5. The conclusion was, that there is a pool of different experiences, of specific knowledge and a good basis for a transfer of ideas not only from west to east, and from east to west too. (Examples are the three German-Polish Conferences on Sustainable Development; cf. Banse et al. 2011; Banse/Kiepas 2005, 2007.)

## 2 Some Activities

At first, let us name some cooperation partners:

- for Poland: Silesian University Katowice (Institutes for Philosophy and Cultural Science), University for Social Sciences and Management Tychy as well as the Technical University Rzeszów;
- for Romania: University "1 Decembrie 1918" Alba Iulia;
- for Russia: Institute for Philosophy of the Russian Academy of Sciences, Lomonossov-University, International Independent University for Ecology and Politology as well as State Technical Baumann University (all in Moscow);
- for the Slovak Republic: Chair for Ethics and Applied Ethics of the Matej Bel-University Banská Bystrica as well as the Technical University Košice;
- for the Czech Republic: Centre for Science, Technology and Society Studies at the Institute for Philosophy of the Academy of Sciences of the Czech Republic, Prague;

3 Cf. the contributions of Andrzej Kiepas and Petr Machleidt in this volume; cf. also Kiepas 2007.
4 Cf. Pechan 1996; but the PIAS don't exists since many years…

- for Hungary: Technical and Economic University Budapest.

Our experience with Budapest University of Technology and Economics: It isn't easy to establish a continuous cooperation (there were many activities like a "mayfly" resp. short-time cooperation – based on different interests, financial supports, persons, etc.).

Forms or kinds of cooperation are:

- initiation and implementation of joint (short-term as well as long-term) activities (in particular research projects, workshops and conferences, publications);
- mutual participation in (national) scientific events;
- holding lectures (e.g., on technology risk assessment, on the philosophy and ethics of science and technology, on sustainability and socio-scientific environmental questions);
- organisation and preparation of translations (e.g., into German, Polish, Russian, Slovak, Czech);
- preparation of stays of guest lecturers (in Germany, Poland, the Slovak and Czech Republic);
- signing cooperation agreements (with institutions in Poland, Russia, Hungary and the Slovak Republic);
- (joint) supervision of doctoral candidates (in Poland and Czech Republic), cooperation in scientific councils as well as in appointed commissions;
- establish joint "real" or "virtual" research and teaching institutions (like International Centre of Sustainable Development and Information Society at Silesian University, Katowice, Poland, or International Research Centre for Social Consequences of Scientific and Technological Development and Innovation at the Lomonossov University, Moscow, Russian Federation).

All this based on different financial support (mostly on support by DAAD [Deutscher Akademischer Austausch Dienst / German Academic Exchange Service], ERASMUS/SOCRATES programme, DFG [Deutsche Forschungsgemeinschaft / German Research Funding Organisation]).

Some specific examples show the different kinds of cooperation:

- Project "Electronic Signature. Cultural Frame and Conditions of a Technological Development" (with participants from Belgium, Czech Republic, Germany, Italy and Poland) – 2000/2001 (cf. Langenbach/Ulrich 2002).
- "International Network on Cultural Diversity and New Media"[5] (CULTMEDIA) (with partners from Austria, Czech Republic, Germany, Spain, Hungary, Poland, Russian Federation and Slovak Republic) – founded in 2002, Prague (Czech Republik) (cf., f.i., Banse 2005; Banse/Krebs 2011).
- "Forum on Sustainable Technological Development in a Globalising World"[6] (with participants of the founder states Germany, Hungary and the U.S., and from all over the world, f.i. Australia, Belgium, Brazil, China, Costa Rica, Mexico, Spain, Switzerland and Ukraine) – founded in 2002, Eger (Hungary) (cf., as an overview, Nelson 2009; cf. also Banse et al. 2005, 2007).

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5 The basic assumption of the CULTMEDIA network is that the interactions between the development of European nations and the use of means of communication that have existed since the invention of the alphabet still play an important role in the present. The introduction of printing with movable letters, print media, radio and television has led to cultural revolutions that have been associated with radical economic, political and social changes. With the development of digital media and computer-mediated communication, and due to the importance of such media for the transition of the present European society/societies to a "knowledge-based society", these interrelations remain effective in the current day. In connection with the transformation of their cultural basis through widespread use of new media, the operational conditions of societal subsystems change, together with the working methods of organizations and the possibilities for interaction between individuals. CULTMEDIA deduces the concomitant changes in the relationship between sociality and culturality in three fields of research, namely "Privacy and the Public Sphere" (for the socio-political dimension of the subject), "Identity and the Community" (for its social-cultural dimension), and "Knowledge and the Economy" (for its socio-economic dimension). In addition, there is a cross-sectional topic "Security/Insecurity and Trust".

6 The basic idea is that because we live more and more through technology, a forum should be developed where a heterogeneous group of people, natural scientists, engineers, engineering researchers, social scientists, philosophers, policy analysts, even policy makers, interested public may meet each other to develop a systematic discourse over topics chosen for the workshops to be realised in each second year. It was also a founding idea that the workshops would be held alternately, one time in Europe and one time in the U.S., to express the importance of trans-Atlantic participation by the places where the discussion takes place.

- Project “Technology Assessment – Methods and Impacts (TAMI)” (with participants from Belgium, Czech Republic, Danmark, Germany, Netherlands, Poland, Switzerland and United Kingdom) – 2002-2003 (cf. Decker/Ladikas 2004).
- “Network for Sustainability Strategies, Monitoring and Management in Southern Eastern Europe” (NESSEE) – founded in 2006, Alba Iulia (Romania) (with partners from some South-East European countries).
- German-Russian Academy of Sustainable Development (based on some institutions in Karlsruhe and Moscow) – founded in 2002, Karlsruhe (Germany) (f.i. a series of conferences “Sustainable Development and Modern Civilisation”, Moscow 2006ff.).
- PhD thesis: Krzysztof Michalski (Technical University of Rzeszów, Poland): Ethics and Technology Assessment in the Most New German Philosophy of Technology, 2003), and Petr Machleidt (Czech Academy of Sciences, Prague, Czech Republic): Technology Assessment in the Czech Republic and in Germany, 2007.

# 3 Some Results

3.1 Gerhard Banse, Christian J. Langenbach, Petr Machleid (eds.): Towards the Information Society – The Case of Central and Eastern European Countries. Berlin a. o. 2000

The background of this publication was the final activity of the project “Technology Assessment und Ethics of Science in Central and Eastern European Countries”, the workshop “From an Information Society to a Knowledge Society: Democracy – Participation – Technology Assessment”, Prague, February 3-5, 1999.[7] More than 40 scientists and experts of various institutions from nine European countries – from universities, academic centers and from various governmental and private organizations – participated in the conference. Approximately two thirds of participants came from EU countries and one third from the Central and East European countries.

The conference program was thematically and organizationally divided into three parts:

- more general and conceptual considerations;
- application areas;
- evaluation process.

Objectives of the conference are

- to express and illustrate various viewpoints and attitudes to the problems of the presented subject matter;
- to make use of the feedback effects, i.e. to attain the exchange of experience and information.

The Prague conference provided a fair overview of the status and perspectives of technology assessment in individual countries of Central and East Europe. However, it also showed the complexity of creation of space for TA type activities in individual countries – for independent activity of both experts and the public based on individual responsibility. As the key role of knowledge in the scope of emerging trends towards the information or the so called knowledge society we consider knowing the limitations of technical and technological applications, possible risks and potential failures that cannot be avoided. More and more important role here is played by the subjective factor, by human being in the full range of capabilities and interests – this is what we call human capital. This also includes the problems of participation and democracy which need to be further discussed with respect to the Internet and safety of information technologies. Searching for adequate relation to technology in the future assumes more comprehensive attitude to the public, which is much more an active bearer of information technologies development than its target.

In principle, the book came from the contributions presented at the Prague Workshop. However, it reflects the ideas and incentives sounded in the discussion. Therefore, the book consists both of the final versions of the presented papers and the new contributions initiated by the Workshop.

3.2 Gerhard Banse, Armin Grunwald, Michael Rader (eds.): Innovations for an e-Society. Challenges for Technology Assessment. Berlin 2002

7 The international conference “From Information to Knowledge Society: Reloaded. e-Participation – e-Identity – e-Society”, Prague, June 15-17, 2011, went back to this international conference directly.

The international congress "Innovations for an e-society. Challenges for technology assessment" toke place in Berlin, October 17-19, 2001, with participants from 24 European and non-European countries, among them from Czech Republic, Poland, Russian Federation and Slovak Republic (cf. Banse et al. 2001).

The congress provided a forum for technology assessment and innovation and technology analysis to scientifically handle and discuss these existing challenges due to currently available or already foreseeable information and communication technology. The plenary sessions and the presentations to working sessions during the congress contributed towards the following goals:

- Investigation of the potential effects and implications of Information- and Communications Technologies in political, economic, societal, cultural and environmental respects.
- Analysis of the institutional assumptions and basic conditions which are necessary or desirable to shape a sustainable and democratic "e-society".
- Proposal and discussion of procedures, through which society's demands for this project can be determined and implemented.
- Improvement of the interface between scientifically fueled TA on the one side, and the expectations of its "systems of application" (industry, politics) on the other. For this reason, there were discussions on how TA can contribute to shaping products and processes within companies.
- Illumination of the potential for shaping within existing scenarios for further technological development and discussion of concrete options for decision-making and action, for instance, in the fields of e-commerce, e-governance, e-health or data protection and privacy in international comparison.
- Enabling mutual learning processes and contributions to improving mutual understanding beyond cultural differences in handling technology and technisation, especially concerning culturally different concepts of an e-society.

The overall aim was to determine, analyse and propose solutions for the challenges of an e-society which arise at the interfaces between science, technological development, the economy, politics, and the general public. The theoretical and empirical analyses presented in the congress were oriented towards constructively shaping the e-society. The various methods of implementing technology assessment in politics and in the economy attempted to identify the preconditions for "best practice" and for "good practice" in advising politics and in industrial technology planning. It was important to consider both types of addressees for technology assessment: the political system – which is responsible for setting the framework for an e-society –, and the economic system, in which concrete products, systems and services are developed for this e-society.

### 3.3 Gerhard Banse, Armin Grunwald, Imre Hronszky, Gordon Nelson (eds.): Assessing Societal Implications of Converging Technological Development. Berlin 2007

This book is the result of the 3rd workshop of the Forum on Sustainable Technological Development in a Globalising World, which took place in Budapest, December 08-10, 2005.

In it are contributions from authors of 11 countries (among them from Germany, Hungary and Ukraine).

Perhaps the most comprehensive challenge in the early 21st century is the promise of the so-called converging technological development based on the recent development of nanotechnology and realising more and more on this base some sort of fusion with such basic technologies and sciences as biotech, informatics and cognitive science. The usual emphasis in assessing this process is made with these elements, in abbreviation the NBIC developments. But it is obvious that what is at stake is the social and environmental change that becomes possible through this new technological wave. All the social sciences and economics are needed to be heavily involved in the assessment of this overarching process that not only promises a deeper penetration of all social relations than any earlier technological wave, but as a result of accelerating trends of each of its constituents, it may cause this penetration in an accelerated way in a very short time. All social sciences/humanities have an essential role in this assessment.

Concerning the convergence characteristics typical of technological development today and especially the NBIC convergence, the present book concentrates on the following elements:

1. It goes back and overviews what happened as converging technological developments in ICT, information and communication technology occurred.
2. It brings cases how nanotechnologies were developed and utilised for such important issues as environmental problems.

3. It brings a rather systematic assessment of the utopias and fictions around nanotech and converging technologies.
4. It gives an overview of research in some countries from which we know less in this respect, China, Mexico, the Ukraine.
5. It gives an overview of research supported at NSF (National Science Foundation), discusses the European Committee 6th Framework program, and efforts by UNESCO to focus on the possible social impacts of nanotechnology.
6. Finally, it closes with articles dealing with the ethical problems in the field.

The content includes papers in the following directions:

- Natural Sciences and Medicine on Nanotech Based Converging Technologies;
- Visions and Utopias;
- Utopian Aspects of the Debate on Converging Technologies;
- Development of Nanotech in Different Countries;
- Social and Ethical Aspects of Converging Technologies.

3.4 Gerhard Banse (ed.): Technological and Environmental Policy. Studies in Eastern Europe. Berlin 2007

This publication presents results of interdisciplinary studies in the field of technology, innovation and environment in countries of Central and Eastern Europe with contributions from Czech Republic, Finland, Poland, Romania and Russian Federation.

The necessity for interdisciplinary technology, innovation and environmental studies in these countries also depends on the following "boundary conditions":

a) there are enormous ecological and economic technology-induced problems and burdens from the contaminated sites resulting from technology utilisation in the fields of energy generation, chemical industry, agriculture as well as transport;
b) there are a number of decisions to be made regarding technical solutions, which can modify, supplement or substitute the currently used technology or which new solutions are to be developed and utilised;
c) there is a need for overview and orientation knowledge as a basis for technology-political decisions in politics, economy and science (especially against the background of the restructuring of the whole industrial basis);
d) it is necessary to sensitise the general public regarding the consequences of technical developments and their utilisation (also against the background of previously refused opportunities of participation and discussion).

The contributions summarised in this book refer to this situation – to a varying extent – and partly give detailed descriptions and mainly offer suggestions for solutions. They are primarily "insiders", who, if they are not actors, they are at least observers, but definitely they are "concerned" by the transformation processes which took or are still taking place.

The content is divided into two parts:

- Technology Assessment and Sustainability;
- Innovation and Economic Transformation.

The book begins with a contribution on the importance of scientific knowledge in and for the modern age. In the texts it becomes obvious that in the individual countries own ways have to be found, independent solutions have to be found and experience must be gained. At the same time this indicates the limits of the transformability of knowledge generated elsewhere – i.e. also under different economic, political, social and cultural conditions – or – in other words – the relationship of general approaches and concrete, specific-national conditions.

## 4 Closing Remarks

1. In a more conceptual direction: In the 1990s were conceptualizations in a specific national manner (eq. topics, relationship research/teaching interests or scientific/public debates), in the present mostly the same topics or debates like in Western Europe (EU membership!) – examples are the relationship between description and evaluation or the role of norms and values in technology assessment, kinds of

participation, … It brings in a broad scientific potential and a broad spectrum of questions, answers and solutions – technology assessment in general, in specific technologies (environmental technologies, sustainable development, new media, …).

2. In a more practical direction: Political power constellations are changing as basic economic conditions change, potentials of science are reorganized or newly organized just as the administrative bodies on state and regional level. Thus, both political aims and priorities and opportunities for social interference and action change as well (occasionally very quickly). Consequently, there was (and is) often a lack of time and continuity required for consolidation and differentiation processes in TA.

Cooperation with countries in Middle and Eastern Europe is a "normal" process today! There is a "pool" for cooperation in TA.

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# Technological Foresight and Technology Assessment. Methods for Enabling Innovations in the Czech Republic

*Petr Machleidt*

## 1 Technological Foresight and Technology Assessment in the Czech Republic

Assessment of new and emerging science and technology in the Czech Republic has always had a significant prognostic dimension. Necessity to use the *"ex-ante"* methods has been stressed, not only due to possible risks of these technologies but first of all to take into account their development and innovation potentials. The practical purpose of these activities is quite evident – and in this sense it is identical with the purpose of the so called constructive Technical Assessment (cTA) – not to restrict but to support and go along with development of new technologies and direct them to meet all-society objectives.

In connection with the prepared "Draft of the National Programme on Oriented Research and Development and on its Implementation" (cf. Klusáček et al. 2001) in the Czech Republic, the need to define more precisely the term "Foresight" came into being. The term "Foresight" was taken here as a concept, encompassing both broadly aimed national projects (analysing in details a starting situation and resulting in a draft of complex provisions to create better conditions for generation and using of knowledge), and projects, aimed at narrower objectives (directed for example towards identification of priorities in a narrow section of the national economy and towards corresponding research and development /R&D/ activities).

Since that time till now, a series of international courses called "Technology Foresight for Practitioners" occurred in the Czech Republic – e.g., in the year 2007 the Technology Centre of the Academy of Sciences of the Czech Republic (ASCR; in Czech: AVČR)[1] in co-operation with UNIDO organised the fifth international course. During this course Foresight was presented as a policy forming tool, especially important for creation of scenarios. The theory of scenarios forming was explained, application of scenarios was used to solve case studies, and last but not least, in the practical part of the course, trainees were made to create their own scenarios. Holding of the course was (as well as in the previous years) supported by the Ministry of Foreign Affairs of the Czech Republic.

Foresight and/or the French style research "la prospective", frequently occurs in countries where TA concept (for all of sorts of reasons) did not take its roots. Experience resulting from the database of TA activities and institutions, compiled by Institute for Technology Assessment in Karlsruhe, showed that it was (for example) very difficult to find out and describe TA activities in France. In Great Britain this term got its ill fame due to political connotations. The abbreviation TA (Technology Assessment) was satirically explained as "Technical Arrestment". TA underwent similar evolution as the term Foresight – during its course of development TA was confronted more and more with requirements for knowledge which could enable it to evaluate science and technology more actively, in order to satisfy (by its contributions) the utmost number of interested persons.

Foresight was always taken as a tool supporting and enabling "an innovation system", namely the national innovation system. Today we can see that TA thematic aims have been also moved towards the problems of "innovations". This shift from TA towards innovations and technology analysis is very significant. TA thus has become rather analysis of relationships between innovations and technology. There is quite evident and enormous pressure on development of innovations, applied by the current society in the field of science and technology. ATA process which would fail to respect this pressure wouldn't have any chance to be practically applied, even in the case that it would accentuate significant social priorities.

The Technology Centre AS CR in cooperation with the Ministry of Education, Youth and Sports (in Czech: MŠMT) and with the Research and Development Council (RVVI in Czech) prepared a draft of thematic priorities for National Research Programme III for the period 2009-2014. This draft shows close relation-

[1] Technologické centrum AVČR (Technology Centre of the Academy of Sciences of the Czech Republic) was founded in the year 1994 as a consortium of legal entities. It is national information centre for European research; it deals with international transfer of technologies, with studies and projects focused on analyses and trends in research of technologies and innovations. It supports formation and development of high-tech enterprises.

ships between activities of Foresight and TA in assessment of trends in science and research development, leading to many-sided support of innovations. A panel of specialists was formed and charged with a task to identify key occasions and problems of the Czech Republic for the time horizon reaching 2015-2020, which could be either used or solved by application of the research supported within the above mentioned draft and consequently to identify related thematic trends of research. When doing this, special stress was put on revelation of inter-branch connections and as well to a multidisciplinary approach.

In spite of the presented differences, the essential point is that both Foresight and TA give answers to the same social questions and problems. There are identical social interests in their background. When an intensive sharing of knowledge and joint actions are in progress, there is no reason for a forcible separation of Foresight and TA activities and processes. If we are trying to find specific significant common features of Foresight and TA, we can see that both activities have reference to such conception of society, which is based on development of science, technology and knowledge. This conception corresponds best with the conception of the so called knowledge society. At present, the conception of knowledge society is accepted across the whole political scene in the CR. It shows that there is wide consensus of opinions on importance of the knowledge society.

The traditional hegemony of producers has been changed in the knowledge society to permanent supremacy of customers and consumers. Knowledge becomes the most important form of capital in this environment. The knowledge society creates, shares and uses knowledge for the prosperity and well-being of its people. By using knowledge an enterprise generates its wealth. A knowledge enterprise in the broadest context is meant any organisation based on knowledge, operating within the knowledge society and making use of all positive trends in its development. The winner in the knowledge society is the person who has knowledge and is able to make use of it. The most important form of capital in a knowledge society is knowledge and ability to generate this capital. Knowledge is not only the basic form of capital in this society, but it becomes also the unique resource of competitive advantages in the global economy.

The Association for Information Society (in Czech: Sdružením pro informační společnost – SPIS) issued “A Knowledge Society Manifesto”. The Manifesto defines a knowledge society as “the society where values are generated by creative and individualised way, not by a routine physical or mental work” (SPIS 2005, p. 13). The ability to create innovative products and services by using modern technology and sophisticated technology procedures becomes the main resource of competitiveness in the economics focused on innovations. Such innovative products and services can be placed in global markets for bonus prices and form the market. Institutions and initiatives promoting innovations flourish. Thanks to their unique strategy, these companies take up competitive positions on the market, frequently even on a global scale. The economy is characterised by a high share of services.

The Governmental Programme No. 272/2005 “Information Technology for Knowledge Society”, accepted for the period 2006-2011, elaborated by the Ministry of Education, Youth and Sports stresses the significance of information technologies for knowledge society and thus also for development of innovations in the Czech Republic. The objectives of the programme are as follows: design and implementation of technical infrastructure for knowledge management in health care, social security and state administration in general development of new information infrastructures for higher educational establishments; development of new methods of knowledgeable management namely by using artificial intelligence, e-learning, and information and data warehouses; design of new mobile and open systems for internet applications and for new types of client solutions in both industry and non-industry spheres; development of new computer security systems including spam protection in order to achieve the highest level of security in the Czech communication and information environment corresponding to world level; provide software and hardware design intended for work of virtual teams and laboratories, development of e-learning methods with the aim to reach at least the peak of the European level; negotiation of language barriers in information and knowledge share within the EU multi-language environment.

## 2 Promotion of Innovations in the Czech Republic

The Ministry of Industry and Trade (in Czech: Ministerstvo průmyslu a obchodu – MPO) of the Czech Republic has prepared a total of 15 supporting programmes within the framework of the “Operational Programme ‘Enterprise and Innovations’ 2007-2013” (OPEI; cf. MPO 2007, p. 87). Applicants can make use of financial means from the programmes for co-financing of entrepreneurial projects in manufacturing industry and for related services. Money comes partly from EU funds (85%) and partly from the state budget

(15%). The money from OPEI will be paid in the form of non-refundable grants, preferential loans and guarantees. Let us present this as an example the programme “Innovations” which promotes two types of projects.

Innovative projects – Czech companies owning projects offering new, original solutions can obtain, within the programme, necessary financial means to buy modern machines, equipment, know-how and licences needed to their realisation. A similar programme was applied in the period 2004-2006. It gave support to more than 100 enterprises and thus contributed to their long-term growth. A series of successful applicants broke through with the new products on European and world markets and they successfully continue in further development of their entrepreneurial activities.

Projects supporting protection of industrial property – in this case the program contributes to protection of intangibles – patents, utility designs, industrial designs and trademarks.

Implementation of innovations and far-reaching application of R&D results in industry and related entrepreneurial services gives rise to very strong potential for faster economic growth. Innovations, taken from the practical point of view, promote creation and maintaining of quality work places (thanks to higher productivity and flexibility, to introduction of more effective technology procedures and management methods, to ability of quick response to any change or occasion on the market). Innovations generate an atmosphere which stimulates entrepreneurs to establishing innovative enterprises.

Intention to promote the field of innovations from public resources should not draw the resources at the expanse of basic research. There is a series of experience gained by countries that successfully surmount unfavourable economic trends, showing that basic research was, all in all, the most productive resource of the most significant and economically successful innovations. A real innovation (i.e., an innovation of the highest degree) is in principle new, revolutionary and thus it takes its origin from basic research. It could be counter-productive to place the needed support of innovations devoted to enterprises against the support given to basic research and consequently it could lead to degradation of innovative capacity and gradually to a loss of a country’s competitiveness.

The Technology Centre ASCR is a workplace which explicitly endorses Foresight and Technology Assessment methods and procedures. It deals with strategic studies aimed at the field of research, development and innovation. The Centre prepares conceptual background papers for the state administration and its advisory bodies, it co-ordinates national and regional projects aimed at proposed research priorities, strategic research directions, preparation of research and innovation policies and innovation strategies. In the field of education and training, the Centre organises courses aimed at education of experts in analytic and prognostic studies.

Innovation performance in the CR according to international comparisons published in European Innovation Scoreboard (EIS) is still below the average European level, but there is a noticeable trend towards gradual convergence to the average innovation performance of EU-27. While in the year 2004 the Summary Innovation Index of CR reached approximately 80% of the European average, by the year 2008 index value climbed up to 85% of the EU-27 average. The most significant shortcomings in the Czech innovation system, according to EIS analyses are considered facts of relatively lower availability of˙ financial resources as well as inadequate qualification of manpower which does not meet requirements enabling faster development of innovative performance (cf. Klusáček et al. 2008).

In the category “Human Resources”, comprising five indicators of availability of qualified manpower needed for innovation, CR reaches approximately 75% of the European average. The relatively inferior position has been affected first of all by comparably lower share of population with tertiary education and further by lower share of graduates of tertiary institutions (universities and colleges providing technical, natural, social and humanitarian education). In spite of the fact that this indicator shows constantly rising trend, CR reaches only about 64% of the EU-27 average. The fact is that at present series of Czech enterprises engaged in R&D feel the absence of graduates of tertiary institutions with corresponding specialisation and qualifications (cf. Čadil et al. 2007, pp. 26-32). The absence of graduates of the above mentioned tertiary institutions and specifications corresponds also with the relatively below average value of the indicator showing share of doctorate graduates in the second stage of tertiary education. Participation in lifelong learning is in the CR also below the European average.

In order to improve competitiveness of the CR a radical change in qualification of manpower has to be realised, namely number of tertiary institution graduates has to be increased. It requires also looking for new forms of co-operation between research and education. Knowledge society asks for reinforcement in the field of knowledge formation and distribution. Basic research plays here its irreplaceable role together with tertiary educational institutions as well as with the educational system as a whole. It will be necessary to look for methods of good practice in other countries – e.g. lately Germany started to apply new perspective models of interconnection between research and education.

There is no doubt that the Academy of Sciences can contribute to improvement of the transfer of knowledge by finding new forms of co-operation with industry, namely by founding of spin-off companies. The Academy of Sciences has to struggle actively for public support; it must improve PR activities and establish feedback for scientific research. Institutions carrying out basic research have to look for their natural allies at tertiary institutions, establish close organisational interconnections and new co-operative relations.

So what is the role of Technology Forecasting and Technology Assessment at present? Is there a scientific reflection of what is now going on in the field of science and research? Is the social process, now in progress, searching for consensus on direction of science in the Czech Republic, analysed by routine methods used in social sciences? Does not the current state of matters very urgently call on corresponding science branches which dispose of advanced and sophisticated methodology to deal with prerequisites and consequences brought by development of science and technology?

TA always drew our attention to complicated and inconsistent relationships that exist between science and research, technology and society, political objectives and public interests. TA does not deal (and never did) only with analyses of science and technology in connection with recognised risks for society, but it deals also with cultivation of relationships among society, public, science and technology, as well as with protection of these relationships against narrow political and economic interests of various pressure groups and lobbyists.

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# Technology Assessment – Possibillities and Limitations of Application in Poland

*Andrzej Kiepas*

The problems of technological development and their negative effects are recently the object of interdisciplinary discussions. In those discussions, the representatives of different sciences have participated. The concept of Technology Assessment (TA) that existed for seventy years of the 20th century has inspired both interests and controversies. From the time of the origin of this concept have appeared different meanings of TA and of its role as a factor for regulation and control of technological development and its effects. From among the different concept of the role of TA, most of those have indicated, that TA can provide

- independent scientifical inquiries by experts;
- political and economical advice;
- one of the stops in the process of decisions about technological development.

Today, the last two roles have had the most important meanings. The role of TA for independent scientific inquiries by experts has lost a little of its meaning. This is connected with the origin of the concept of TA. The conviction about the fallibility of scientifical theories was connected with the conviction about the fallibility of inquiries by experts. Inquiries by experts was connected with the different subjective assumptions, which has strengthened the conviction about the relative character of those inquiries, which has saped their independence. It was connected additionally with the limitations of the concept of TA, and about this we will write in the next part. The role of TA for political and economic advice and as one of the steps in the process of decisions about technological development are connected with the role of TA as a factor in reduction or solution of conflicts, their origin in connection with technological development. The contents of those conflicts are connected with the relations between technological actions and society (individuals, groups), and their use is technology in those actions. The conflicts in this case are connected with

- the effects of development and diffusion of technology;
- the tasks, that with this development and diffusion are realized; those tasks have different species, and for example they can be expectational tasks, consciously or not consciously realized tasks, and others;
- definite goods, that can have material or not material character.

Those three are mutually connected. The effects of technology development are connected with the tasks, but the tasks can have subjective character and the effects are in the majority objective. The effects of technology development create potential for different conflicts. Those effects have meaning and different influencies for individual persons, social groups and for all society. The potential of conflicts is connected in this case not only with the magnitude of the effects, but with the subjectiv factors, there are for example connected with their description and understanding. The role of subjectiv factors in the different conflicts arise today with the development of the socalled "Risk Society" (cf. Beck 2002). The origin and development of risk society is connected with the change of modernization processes and with the cross from direct modernization to reflexive modernization. In the case of an industry society the tasks are connected with the reign over the world and nature. Nature is understood as an object to the form for science and technology. The basis for this modernization has lain in the development of instrumental rationality, which is connected with the search and choice of the best and optimal means related to the definite tasks. Reflexive modernization is not so much a primary character because the basis for this modernization is direct modernization (cf. Beck 2002, p. 17). The objects for reflexive modenization are those things, that are transformed in the process of direct modernization. Modernization has in this case myself as a object. The differencies between a risk and industral society are connected with the change of the main tasks. In the industral society the main tasks were connected with the production of welfare and in the risk society with the production of risks (cf. Beck 2002, p. 20). The risk origin is a result of:

- not only consciousness effects , but they are connected with the causual and not intentional effects;
- the cumulative character of effects; the single parties of definite processes can be consciously provoked and controled, but the last effects lose the conscious character, and it is connected with them, that the

societal actions have as a subjects not individuals but institutions; those actions have net character too, and this situation provokes the casual effects (cf. Beck 2002, pp. 20f.).

The origin of risk is not the result of direct relations causes-effects, but the result of different factors and conditions. It is not possible that those factors are directly perceived and therefore risk is dependent from their assessment and description. Risk is dependent from the interpretation and in the end from science and technology. Risk has not only objective but subjective character. There is more risk than in reality, because risk depends from theoretical description and reconstruction. The situation of risk is connected with the definite features:

- risk has specific and concrete character, but at the same time it is universal;
- the ways from causes to effects are complicated because their relations are'nt in time and space directly connected (cf. Beck 2002, p. 38).

Risk is today the result of development of science and technology, but on the other hand it requires science and technology to recognize, assess and control risk. Science and technology have changed their role in the risk society. The decision about truth is dependent not only from internal authorities, but from external factors, criterions and authorities (social groups). On the other hand, it is true that the external results of development of science and technology, e.g., causal effects, are the object of research in science and technology (cf. Beck 2002, p. 255; cf. also Kiepas 2000, pp. 60f.). Technology assessment shows this situation.

The conflicts in the risk society are the result not only of the real effects, but they are the results of different ways of description. The objects of conflict can be the effects, tasks or goods. The basis of conflicts is situated not only in the objects, but in notions and in the ways of behaviours of the subjects to the definite objects. There are additionally two kinds of conflicts, namely the conflicts of interests and the conflicts of divisions. The conflicts of interests have as an object the effects, or the tasks. They are most often not directly dependent from technology, but they are connected with technology. The conflicts of divisions have as an object the effects and goods. The division of effects and goods built in the risk society the basis for different conflicts (cf. Gethmann/Sander 1999, p. 147). It is possible to recapitulate and show two kinds of conflicts:

1. The conflicts according to their objects: the conflicts of effects, tasks and goods.
2. The conflicts according to their function: the conflicts of interests, divisions.

TA has a definite role as a factor for solution of conflicts in different area. Those roles are connected with different tasks:

- strengthen political advisory role;
- strengthen communication of knowledge for the citizens;
- participation of citizens in the chosen area (cf. Hennen 2004, pp. 10f.).

The different models of TA are connected with those tasks:

1. Model of work division between science and politics: TA has here the role of a warning system and strenghthen as of the political advisory role – e.g., model of Office of Technology Assessment in America or VDI in Germany;
2. Model of social participation: TA has here the role of solution of different conflicts (cf. Grunwald 1999, pp. 12f.).

TA contains procedural, cognitive and axiological issues. The development of TA has shows that the application of TA is connected with the different problems and limitations, and among others with the following:

- *Dilemmas of facts and values*: the limitations concern here the possibilities of realizing different values; realizing one value at the big level can't to lead unnecessarily to other values on the same level; for example, to realize technological values can't directly lead to realize other values; the relations between the different values aren't in all cases direct and functional, but they can be in the situation of conflicts; this dilemma is connected with different conflicts for scientists, politicians and for citizens; the limitations of TA are connected here with the problems, that are characteristic for the ethics of values; the problems are connected among others not only with the nature of values, but with the different expectations of individuals and social groups; it is difficult to give the universal list of values with the range of their weight.

- *Dilemmas of participation*: it would be here the solution of those dilemmas of facts and values with the ethics of discussion.

The model of participation of social groups in process of TA has reached in last years a big meaning. The realization of those models can't provide automatic solution of all dilemmas and problems. There exist different ways in this model of participation:

- limited discussion: the task here strengthens the definite social groups choosen about technological development;
- not limited discussion: all citizens can participate on TA and can give veto against the definite chosen solutions;
- consensus conferences: the idea has origins in America and in Denmark; the task here is to include the member of different social groups and citizens to discussion about the problems of development of technology and their effects (cf. Grunwald 1999, pp. 18f.).

The models of participation have positive and negative issues. They are connected with the definite possibilities but simultaneously with the problems. It is possible to reach with TA: the diffusion of knowledge about the technology and their effects, the development of systems of confidence in the society, to make transparent the processes of decissions. It isn't possible to reach: the full justification and solution of values conflicts, on the full solution of limits in participation. It exist here among others the danger to mix up the factual with the right. Actual acceptance isn't synonymous with the right acceptance. The participation of society can't replace the role of democratic and state institutions. The basis for the participation is the development of citizen society, but simultaneously the application of TA gives the possibilities for the development of this society. The both processes – the chosen and the solution of conflicts – are connected, but simultaneously they have their own dynamics. Those processes contain the different issues: institutional, cognitive, procedural, ethical. The idea of societal form of technological development requires:

- to include the society and their citizens: the consideration of different social interests and the development of knowledge in the society;
- the creation of society: to build the basis for the public discussions of citizens (cf. Grunwald 2000, p. 294).

Those tasks are significant for both parties: for the society and for science and technology. The diffusion of knowledge about technology and their effects can develop a system of confidence for individual persons and for different social groups, and can form their sensibility and understanding for the needs and interests of other people. The role of participation is different in the case of concrete conflicts. The bigger role is in the case of conflicts of effects and goods. The conflict of tasks requires the choice of values and in this case the role of TA has definite limitations. The conflicts of interests and divisions are difficult to solve with the methods of TA, but TA can have here a certain role. The methods of TA must be connected with the other procedures. The diffusion of TA procedures built upon the basis for the solution of different problems and conflicts that are connected with the development of science and technology. The application of TA builds the potential and that means the building of society and culture. It has definite meaning in the national and in the international scale.

The practical possibilities of application and use of TA and the limitations of this process have different causes and concern the following issues:

- scientifical and technological;
- economical;
- political;
- societal and cultural.

It was undertaken in Poland over the eighteen years to try to build the institution of TA, but those trials didn't yield positive effects. Those difficulties show the limitations for the application of TA, not only in the specific situation in Poland, but they shows the universal limitations. (cf. Kiepas 2007, pp. 75ff.) In the case of Poland and in the case of other states there exist problems that are manifested in the earlier indicated issues:

1. Scientific and technological: there exists definite "lacks" and for example the lack of the institution of TA and the lack of persons who research the problems of technology; the lack of scientific staff in the area of TA is connected with the educational programms in technology; those programms lack TA as an

educational object; the problems of development of science and technology haven't been in Poland the object of interdisciplinary research and therefore Poland lacks the definite experiences in this field. Poland is from few years ago an associate member of European Parliamentary Technology Assessment (EPTA) via the Bureau of Research of the Chancellery of the Sejm (BAS). "The main task of the BAS is to provide independent reports and expert opinions upon request of individual MPs and parliamentary committees. The BAS also carries out, on its own initiative, research and policy analysis on topics relevant to the work of Parliament. The areas covered are quite broad, starting from constitutional and legal matters, EU regulations, up to social and economic analyses and technology assessment. Most of the BAS research is carried out by its own staff but some studies are commissioned to external experts, think-tanks or academic institutions. For the purpose of encouraging public debate, BAS also prepares publications covering subjects related to the current and forthcoming legislation and matters of public concern. The BAS publishes a series of short briefing notes (Infos) containing concise 4-page analyses of current social and economic issues as well as more elaborate reports (Studia BAS). In the exercise of its advisory function, BAS participates in organization of conferences and seminars in co-operation with the Sejm committees. One of the aims of the Bureau of Research is to monitor the consequences of current and future trends in technological development and to provide information concerning selected issues within the scope of the Sejm consideration".[1]

The initiatives of BAS haven't necessarily been of a systematic and sustainable character; those initiatives embrace:

- the magazine "Infos": about 35-40% of articles in this magazine are concerning directly in the field of TA- the problems are for example: clean coal technology, information society, nuclear energy;
- conferences and workshops: about 15% are concerning directly with TA, the subjects are, for example, climate change, the economy of waste.

Those initiatives haven't a connection with the problems of TA a systematic character and the results arise not from use of interdisciplinary research and methods of TA; in connection with the lacks of that research of TA in Polish tradition the initiatives of BAS are not sufficient, but at the same time are important as the first step of development of research in TA.

2. *Economical*: effective connections between science and economy don not exist and in consequences it provokes the lack of a definite politic in the range of scientific and technological research; the technological progress has in the case of Poland in the last years an exterior character; as a result of this situation were the changes in the scientific institutions and the lack of definite politics in the area of research and development (R&D); the technological progress was provoked by big economical concerns, and it is to be seen, for example, in the case of European scientific and technological framework programs.
3. *Political*: the lack of a definite democratic structure to take up chosen projects and control. This means the lack in the area of political culture, that is important in the participation model of TA. There does not exist here in Poland so much experience and examples of local initiatives and participation in technological choice: it hasn't formed in this case the societal accepted and practicable skills of participation in the control of technological development. There exists in Poland the laws, regulations, that the societal assessment and acceptance for example of the plans of space forming in the local scale, but the level of societal consciousness and competence is at the moment insufficient.
4. *Societal and cultural*: to manifest oneself in the area of broad understanding of technological culture; technological development and their effects require the connection of different competencies; cognitive (knowledge), instrumental, axiological (ethical); the forming of those competencies require changes in education, e.g., by the education for democracy; the participation in the democratic possibilities require definite skills; one of the negative factors in this case is connected with the unequal encampment of technological effects; the effects of technology concern unequally different social groups, that in the case of the participation model of TA require the definite level of sensibility, understanding and solidarity for the problems of other people. There exists in Poland the economical and political differencies and they are the negative factor for the building of those skills and competencies; e.g., in the case of unemployment the economical factors have the decisive meaning; there exists a passive acceptance for definite choices about technological development.

Those factors provoke the thought that the development of science and technology is not the object of effective control and choice of different social groups. It appears in this context that the question of TA is one model only for highly developed states, and/or it is possible to find one's own model of control of technological development. In this time of globalization, there is connected with the development of science and

[1] Cf. www. eptanetwork.org; http://www.bas.sejm.gov.pl.

technology, the search of this specific way must be specific too. There exists on one hand the universal tendencies, and on the other hand in the global order the local and regional level reach a peculiar meaning. One need not exclude the second. The search of this specific way is the task which stands for Poland, and not only in the area of development of science and technology.

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# Uncertainty and Local Knowledge in Environmental Policy: Forestry Research and Regulation in Northern Spain

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## 1 Introduction

Reforestation in Northern Spain with fast-growing exotic species, and in particular eucalyptus plantations in the autonomous region of Asturias, has produced a strong social controversy in the last decades. Popular actions such as the one carried out in 1988 by the people of Tazones (a small coastal village in Asturias), pulling up a private eucalyptus plantation and facing Spanish federal police *(Guardia Civil)*, are only the tip of a troublesome iceberg of confronted expertise and political stances involving agriculturists and stockbreeders, biologists and forestry engineers, the wood and paper industry managers, ecologists and nationalist activists, economists and politicians, and laypersons in general. How has all this trouble arisen if, as claimed, politicians are supposed to develop the best forestry policy, i.e. a socially sensitive policy which is additionally supported by the best available forestry expertise? Eucalypts were familiar news in the local media during the 1980s and 1990s. Nowadays, although the public debate has subsided, the conflict remains unsolved and reappears from time to time (cf. Cerezo/Garcia 2002).

Keeping this target question in mind, we wish to exemplify and comment here on the ubiquitous role of uncertainty that characterizes the processes of expertise production and consequent policymaking (cf. Wynne 1992b).[1] In our view, the analysis of the structural nature of such an uncertainty accounts for the steering role of non-epistemic utilities in the so-called social shaping of environmental technologies and management programmes. The examination of particular uncertainties affecting both expertise production and decision-making through the case study, together with discussion of the complex social nature of environmental intervention and the relevance on lay knowledge, will establish the basis for vindicating the public participation in adequate environmental management.

The vindication of public participation on technological issues typically makes use of three different kinds of arguments. These are what Daniel Fiorino calls the *substantive* argument (to claim the soundness of lay judgments), the *normative* argument (to reject traditional decision-making as inherently antidemocratic), and the *instrumental* argument (to maintain that participatory decisions help to prevent social resistance; cf. Fiorino 1990). The normative argument has been widely discussed in the literature on participation (cf., e.g., Care 1978; Fiorino 1990; Laird 1993; Renn et al. 1995; Shrader-Frechette 1995), but the discussion about how non-experts can substantively contribute to more adequate decisions has only recently begun to receive serious attention in the literature on lay involvement in technological issues (cf., e.g., Bucchi/Neresini 2007; Callon/Rabeharisoa 2003; Leach et al. 2005). What we mean by "substantive" contributions by lay people, borrowing the expression from Fiorino, are perspectives, information, methods and solutions different from those of experts that can shed light on the problems at stake. We will be arguing then that public participation could not only contribute to the improvement of the democratic quality of decision-making in technology and environmental policy (normative argument), but also to the improvement of the decisions themselves, rendering them more efficient (in relation to given aims) through local knowledge (substantive argument) and the promotion of consensus, social stability, and the trust of citizens in institutions (instrumental argument).

As mentioned, the discussion will be carried out through a case study: forestry research and policy in Northern Spain and, in particular, the debate that took place during the 1980s and 1990s in the Principality

[1] It is in Bryan Wynne's sense that we will be using the terms "uncertainty"' and "ignorance". He differentiates between the terms above and that of "risk". Whenever the system's behaviour is basically well-known, so that we know the odds, we can talk about risk. We are able to talk about uncertainty when we know the main system parameters but not the probability distributions. If we do not know what we do not know, then we are facing ignorance.

of Asturias around the promotion of reforestation technologies with fast-growing exotic species.[2] This story, which is the story of the technocratic introduction of the eucalyptus into the Asturian social and natural environment, is sketched in the next section. The following two sections are devoted to showing the diversity of ways in which uncertainty affects the decision-making processes (technological and political) related to the solution of the eucalyptus controversy. After that, we turn to the consequences of disregarding uncertainty through technocratic management, and propose an alternative democratic management in which not only public opinion, but also lay knowledge, plays an important role. At the end, we come back to the eucalyptus controversy showing that it is still alive in spite of political efforts to solve it. We argue that the inclusion of lay knowledge in the processes leading to political decisions in our case study could have provided new perspectives and useful information, apart from preventing the social instability which eventually appeared in our case study. The theoretical framework of our analysis is based on well-known STS literature (cf., e.g., Jasanoff et al 1995; Hackett et al. 2007).

## 2 The Eucalyptus Controversy

The *Eucalyptus globulus*, or white eucalyptus, originally comes from Tasmania, and was introduced into Northern Spain at the end of the 19th century.[3] The rapid growth of this species, the characteristics of its wood (especially appropriate for the paper and mining industries) and its excellent adaptation to the climatic conditions of the Cantabrian and Atlantic coasts, are the conditions which made possible the massive eucalyptus reforestation that took place in Spain during the dictatorship of Franco (1939-1975). The rise of Franco to power in Spain, after the 1936-1939 Civil War, signified an important change of attitude in official forestry policy. This was a change executed in practice by the 1940 General Act of Reforestation *("Plan General de Repoblaciones")* of the Spanish Ministry of Agriculture, under which it was planned to reforest with eucalypts and pine trees up to 6 million hectares (ha) over the following 100 years. The objective was then formulated as "the forestry reconstruction of Spain" (cf. Castroviejo Bolibar et al. 1985; MA 1951). The change of attitude embodied by such a "reconstruction" was a crucial turn from the model of multiple and integrated use of the forest into the model of unique and segregated use of such. The former model responds to a conception of the forest as a producer of well-being within the framework of the rural community – a multiple function integrating a diversity of economic commodities (e.g., wood, fruits, resins, honey and hunting), conservation, rural employment and leisure. A horizontal integration of natural silviculture with rural activities (such as agriculture or cattle breeding) and local industries (such as those of furniture) is pursued in this traditional model. On the contrary, the model of unique and segregated use responds to a conception of the forest as a producer of economic benefits within the framework of the broader market economy – a single function requiring the segregation of production from protection and other activities such as traditional cattle breeding (which are incompatible with monocultures and acquire a secondary standing within the industrial orientation). Production is promoted through artificial plantations (culture-like), mechanization and temporal employment (so as to achieve short-term benefits). A vertical integration of forest-industry-commerce is pursued in this model of artificial silviculture (cf. Groome 1990, pp. 76ff.).

The post-war implementation of this latter model through the intensive planting of fast-growing species has eventually led to different kinds of social and environmental changes in Asturias. These changes include, firstly, transformations in the landscape of a large part of the coastal areas. Secondly, ecological changes affecting the diversity of autochthonous flora and fauna; and, thirdly, changes in the economy of the region, because eucalyptus planting is strongly related to certain industrial sectors (such as cellulose production).

In this sense, the transformation of a rural economy based on cattle raising and multipurpose mixed wood forests, already in motion due to factors such as industrialisation, the migration of the rural population to urban areas, and the agricultural policy of the European Union (EU), was thus accelerated by the introduction of eucalyptus in Northern Spain.

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2 The forestry administrators have similar problems all along the North Atlantic coast of Spain with a number of non-autochthonous vegetal species, but we will restrict our case study to the most troublesome species in a particularly problematic area: the eucalyptus in the autonomous region of Asturias. Asturias has a population of over one million, and a geographic area of 10,565 sq km. The surface area occupied by eucalyptus in Asturias has been estimated at present to exceed 25% of the total forest area of the region, although no exact figures are available (due in part to the rapid uncontrolled development of eucalyptus plantations).

3 Cf. Groome 1990 for a critical history of Spanish forestry policy.

The Asturian landscape, economy and society have all been undertaking transformations partly derived from the changes in soil exploitation and, particularly, from the proliferation of reforestations with the fast-growing species suitable for the paper industry. Opposition to eucalyptus planting, by broad sectors of the Asturian public, erupted in the early 1980s. Expert opinion, being generally perceived as decisive for appropriately handling environmental issues, was then called for by all social groups concerned: the government and paper firm managers, on one side, and ecological groups, farmers, and a diversity of public interest groups, on the other. And expert opinion happened to support all confronted sides: pros and cons. Partly, as a result of the disagreement among experts, duly echoed by the press at the time, a confused public opinion rapidly evolved towards a contra position, with some important political consequences.[4] Among these, a change in the official view of the regional administration which resulted in the enactment of regulative measures. The legislation that regulates eucalyptus reforestation, as well as the authorities' decisions to allow or not allow specific plantations (i.e., the particular implementation of the law), was then presented to the media and public opinion as the "logical" consequence of excellent scientific research – the best available expert opinion, and hence supported by technical reports drawn up by biologists and forestry engineers. Politicians are then supposed to develop the best forestry policy on the basis of the best forestry expertise. However, the eucalyptus controversy is still with us.

Our point here is that the technical assessment carried out by those forestry experts is far from sufficient when determining the most adequate political measures. "The best forestry expertise" constitutes rather a selection among a diversity of alternative positions making up so called "expert opinion". Moreover, the technification of the eucalyptus problem and its technocratic management, thereby disregarding the complex social dimensions of environmental intervention, has produced a diversity of negative unforeseen consequences. Actually, these consequences could have been partly prevented by incorporating public opinion into the policymaking process, that is, by promoting public participation.

## 3 The Sources of Uncertainty

An interesting structural uncertainty affects forestry research and policy in our case study. It is a kind of uncertainty, sometimes termed as "indeterminacy",[5] which cannot be solved with more specialized knowledge thus requiring its social closure by means of non-epistemic utilities.[6] There are indeed several contextual interests and values (economic, political, professional, cultural ...), besides inductive inference and deductive reasoning, that critically contribute (and need to do so) to the shaping of the technical reports elaborated by the experts. In the same way, the result of these reports does not unmistakably determine, in its turn, the adoption of particular legal measures or their application in the particular case, since several, equally well-founded, laws and their implementation could be based upon the same technical report.

A severe indeterminacy thus occurs in every stage of the process which starts with the recognition and statement of the eucalyptus problem as a legitimate social problem deserving treatment by forestry experts, goes through the production of a technological system (e.g., reforestation research and technologies), and eventually leads to the enacting of legislative measures concerning the regulation of the environmental intervention programme intended as solution for the initial social problem. These stages constitute "branching points" which open the way to a number of possible different decisions, whether by experts or politi-

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4 The policymaking aspects of the Asturian case are commented on with further details in López Cerezo/González García 1993.

5 It is also in Wynne's sense that we will be using the term "indeterminacy" (cf. Wynne 1992b). By "indeterminacy" Wynne means open networks or causal chains. Thus, while "risk", "uncertainty" and "ignorance" can be considered along one dimension, in our opinion, "indeterminacy" certainly belongs to another category, since it is embedded within the very definition of risks or uncertainties. As we see it, the point here is that different probability distributions and system descriptions, and thus different kinds of risk and uncertainty, are always compatible with the same judgement elements (say, empirical evidence). It is this uncertainty embedded by indeterminacy that we call structural uncertainty. Besides, and this is a controversial point, we consider these concepts as closely related to that of scientific underdetermination – a concept much discussed in the philosophical literature. As a sample of this literature, cf., e.g., Quine 1975 as well as Newton Smith 1978.

6 Empirical evidence, logic and cognitive virtues (such as simplicity or explanatory power) are here jointly called "epistemic utilities". These are the factors which, in the traditional image of science, are rendered responsible for the production of objective knowledge. On the contrary, "non-epistemic utilities" will be those contextual interests and values ordinarily attributed to the "social context"; cf. Longino 1990, 1996.

cians, which are "epistemically equivalent" in the sense that none of them can be said to be the best one,[7] and "pragmatically incompatible" in the sense that these decision-making knots open alternative courses for action depending on the decision output. Eventually, the result is that "hard decisions" on matters of general interest have to be adopted on the basis of "soft facts" (cf. Funtowicz/Ravetz 1990a, 1990b).

Forestry expertise has been mainly used in Asturias as a political artefact to transform a social problem into a supposedly technical issue where the above structural uncertainty is hidden under a discourse of objective scientific knowledge. However it is also a dangerous artefact, for the technification of the eucalyptus problem, thereby excluding public participation, has produced a reduction of the problem's complexity by disregarding its intrinsic uncertainties and this, in turn, has resulted in negative consequences of an economic, environmental, social and even political kind. Public participation, and the lay knowledge which it encompasses, could have offered new sources of information and new perspectives for dealing with the eucalyptus problem in a more adequate way, i.e., both legitimate and efficient, besides, of course, preventing a negative public perception and social resistance (see below).

Actually, technological systems depend on a full variety of cultural, political and economic parameters (which may jointly be called the "socioeconomic system") which decisively contribute to the shaping of legitimate problems, acceptable solutions, and constrain the temporal change of technological systems in a diversity of ways.[8] Technologies are certainly integrated in wider socioeconomic systems where they establish complex links of functional interdependence with other technologies, as well as with different cultural, political and economic parameters.[9] In this complex setup, technical assessment is far from sufficient for an adequate policymaking. All sources of relevant information and perspectives should be taken into account, including particularly those of the affected people who have a familiarity with the socioeconomic system. Disregarding the complexity of technological systems by a reductive technification of the troublesome issues has politically transformed here the necessary "lab indeterminacy" of expertise into "endemic ignorance" (Wynne's term) in policymaking.

Let us first comment on the indeterminacy skeleton, and then we will tackle the consequences of its technical disguise.

## 4 The Many Faces of Forestry Uncertainty

We will now follow the transformation of the eucalyptus problem through different realms (the social, the experts' and the politicians') to return once more to the social realm with the environmental, social and economic consequences of an inadequate management, and also, we can say, with a transformation of the problem itself.

### 4.1 The Social Realm

Eucalyptus reforestation has become a problem in Asturias because it embraces a number of conflicting interests. Different views of the forestry problem underlie the dispute and the definition of the eucalyptus controversy. What kind of problem is "the eucalyptus problem"? Currently, there are three different viewpoints from which to understand the problem:

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7 "Epistemically equivalent" means here that the different alternatives can be argued as equally supported by epistemic utilities

8. Both technological innovation and environmental intervention programmes are meant by the phrase "technological system". We consider that our approach here to environmental intervention can be in general extended to technological innovation. For particular uses of the concept "technological system"; cf. Bijker et al 1987; cf. also Pacey 1986.

9. In this way, the discussion on technological change can be enriched by making an analogy with the concept of "ecosystem" in ecology. It is a well-known fact that a fragile equilibrium distinguishes the different ecosystems that, more or less stable, more or less free from human intervention, can be found in the natural milieu. The introduction of a new species can generate a situation of instability that can sometimes end up in catastrophe. The examples are, unfortunately, well known. By analogy, the equilibrium of a given socioeconomic system depends on how we might eventually handle the introduction and development of new elements, such as social or environmental technologies. Among the main elements responsible for such an equilibrium, at least in the case study we will be discussing further on, we would like to point out the preservation of the natural resources and the environment, the maintenance of economic development and the avoidance of social instability.

- As an *ecological* problem. This was the first formulation of the problem. When initial social resistance appeared, the discourse against eucalyptus was, first of all, an ecological discourse. Eucalypts had negative effects on the ecosystem of Northern Spain. They were accused of affecting in a negative way the soil, the water regime, and the adjacent cultures, as well as for being a fierce competitor for the autochthonous flora and fauna, favouring forest fires (a significant problem in Spain) and helping the proliferation of the polluting paper industry. Green activists were the first people to highlight eucalyptus reforestation as a problem in Asturias through the communication media. Eucalypts were transformed overnight into the *bête noire* of the Asturian countryside, and ecological reasons were presented as the main arguments against eucalyptus planting.
- As an *economic* problem. Eucalyptus as an economic issue was the main argument put forward by the defendants of eucalyptus reforestation (paper industry managers and majority of administration officials at the beginning of the controversy). Eucalyptus plantation was, however, recognized as not being the ideal way to reforest the lands of Northern Spain, but was considered as a perfect solution to the problems faced by the rural economy, e.g. EU milk quotas and the growing economic crisis in Spanish agriculture. Eucalypts were said to produce quite important short-term benefits, while autochthonous forests of oaks or beech trees, mainly used for quality furniture, were known to offer only long-term benefits (as they have a cutting turn of forty or more years, while the eucalyptus is ready to be cut in 12 or 14 years). Thus, the growing demand for cellulose in the regional and European market, for which eucalyptus wood is especially appropriate, appeared to support the justification for massive reforestation.
- As a *political* problem. Eventually, the eucalyptus problem results in a political problem. It is not only that nationalist parties adopted the eucalyptus as their particular war-horse, by pointing out that it is a foreign species and defending autochthonous forests; but also that, due to public opposition, the government was placed in a dilemma: either to attend to the interests of the paper and wood industries (in a time of general economic crisis) or to public pressure, risking the loss of votes. The autonomous government then went through a series of stages of unconditional support, official sponsorship included, to a position of ambiguity, to institutional blockage of plantations, and back to a position of public ambiguity. The promise of a clear and definite Forestry Act *(Ley de Montes)* was not met until 2004, two years after the Asturian Forestry Programme *(Plan Forestal)* was approved, not without controversy, by the regional government.

## 4.2 The Experts' Realm

The underlying idea supporting the call for scientific evaluation and advice, as an appropriate and privileged referee for stating and solving social problems such as the eucalyptus one, is the supposed neutrality and objectivity of expertise (along with its efficacy, of course). However, if anything can be learned from recent STS research it is that contextual values and interests ("non-epistemic utilities") inevitably affect expert judgement. Yet there is nothing particularly wrong about it, for it is the only "ball game in town", and an effective one indeed. It is only as a reified myth that the ideal of neutrality and objectivity of expert judgement is politically dangerous (cf., e.g., Brown 1987; Shrader-Frechette 1985; Wynne 1975).

The presence of indeterminacy in the experts' realm is shown by evidence of unsolvable disagreement among experts. Scientific authority is called on by the diverse parts involved in the conflict in order to support opposed claims. Each party joins the controversy with due support by their own experts and counter-experts: starting from alternative ways to approach and handle the problem, using different sets of raw data and ways to digest them, they eventually reach alternative conclusions and incompatible practical recommendations. Indeed, the most well-known and quoted reports on the effects of eucalypts at the time of the controversy outburst are an example of this. We can briefly examine three representative technical reports on eucalyptus which have been widely used by the confronted sides of our case study:

- The FAO report "Efectos Ecológicos de los Eucaliptos" ("Ecological Effects of Eucalyptus"), by M. E. Duncan Poore and Clas Fries (cf. Poore/Fries 1987).
- The so-called "Bernáldez report" "Effects des Plantations d'Eucalyptus dans le Nord de l'Espagne" ("Effects of Eucalyptus Plantation in Northern Spain", by Fernando González Bernáldez, Manuel Ruiz Pérez and Catherine Levassor, prepared for the EU, The Commission of the European Communities (cf. González Bernáldez et al. 1989).
- The CEASA report "Sobre el Eucalipto" ("About Eucalyptus"), by Salvador Bará Temes, José L. Montero de Burgos and Antonio Rigueiro Rodríguez (cf. Bará Temes et al. 1990), prepared for the Asturian paper firm CEASA (Celulosas de Asturias, S.A.).

The titles of the two main reports are already representative of significant constraints in scope. While the FAO report only attends the biological aspect of the issue, the Bernáldez report considers a broader field of factors but restricts its analysis to Northern Spain. On the other hand, the CEASA report, which resembles a scientific brochure written for the general public, intends to assess eucalyptus plantations by confronting the diverse criticisms more frequently made against this type of tree.

Concerning the provision and processing of raw data, substantial differences result from the choice of sources and types of data. The FAO report handles information about the most controversial issue concerning eucalyptus planting: its ecological effects. It takes up the eucalyptus impact on the water cycle, erosion, the nutrients balance, soil quality, as well as its possible competition with other alternative uses for soil. Data are provided by a number of studies coming from a small number of countries in which information was available: Australia, Brazil, India and some Mediterranean countries (cf. Poore/Fries 1987, p. 2). This report's methodology merely consists in the comparison of the different sets of data contained in those studies, which severely restricts the report's scope and content. There is no reference to the suitability of eucalyptus as forestry harvest nor to culture and tradition (e.g., significance of eucalyptus in autochthonous forestry landscape, perceived aesthetic value ...). The analysis of the economic and social impact of eucalypts is omitted, and justified by mentioning the difficulty of distinguishing between ecological and social costs.

On the other hand, the Bernáldez report gathers data that, although restricted to Northern Spain, concern not only ecological effects but also, and especially, socio-economic impacts: demand for eucalyptus wood, actual and expected productivity, costs related to the starting and maintenance of exploitations and the reclaiming of the land in the case of a change in use, profitability as compared to other harvests, fluctuations in the wood market price, demand for seedlings,... In relation to the biological aspects, besides displaying information coming from a number of different studies (the FAO report is quoted a good number of times), it includes field work on diverse eucalyptus plantations in the regions of Galicia, Asturias and Cantabria, comparing the biodiversity of eucalyptus areas with the biodiversity of chestnut-tree, holm-oak and pine woods in the same geographical zones.

An analogous diversity between the reports above is found in the drawing of research conclusions and the evaluation of policy proposals, where gains and losses involving different forestry possibilities related to eucalyptus are assessed in terms of the kind and intensity of environmental, economic and socio-cultural impacts previously identified and analysed. Factors such as the planned species to be used (there are more than 600 species of the genus *Eucalyptus*), the climate, the supply of water or the height of the area to be reforested are fundamental to decide the type of conclusions – pro or con eucalypts – which one will obtain. Since the ecological effects of eucalypts vary considerably depending on the area or place where the reforestation is undertaken,[10] the FAO report offers hardly any conclusions (nor any particular policy recommendation) because of the generality of its analysis. It is stated as follows: "In conclusion, after having examined in great detail available evidence, one must emphasize that there is not and it will be not a definitive answer, in favour or against eucalyptus plantations" (Poore/Fries 1987, p. 68).

Although the explicit purpose of the FAO report was to provide a useful tool for those involved in decision-making concerning forestry resources (cf. Poore/Fries 1987, p. 2), the interpretation of this ambivalence of eucalyptus is left to the context, or else to the politician who must legitimate a forestry policy mainly based on economic considerations and respond to ecology activists in the regional press.

In contrast, research conclusions in the Bernáldez report are certainly more precise and stronger: "The expansion of eucalyptus planting in Northern Spain is ecologically negative. [...] The expansion of eucalyptus will contribute to the deterioration of rural economy in the affected areas. [...] The situation grows worse when considering the difficulty of substituting eucalyptus plantations. [...] The powerful and pollutant paper industry creates less jobs and less added value than furniture firms based on quality woods" (González Bernáldez et al. 1989, pp. 40f.).[11]

This leads the authors of the Bernáldez report to a specific policy proposal. They particularly advise against the promotion of eucalyptus reforestation and paper industries through the financial policy (tax exemption and low interest loans) of the public administration, recommending instead the channeling of such financial

[10] Geographical area, climate and specific location (e.g. closeness to a water source or creek, or else to a crop that might be affected), are essential factors when assessing any eucalyptus planting project.

[11] As is shown by these words, it is often difficult to neatly distinguish in particular cases between so-called scientific conclusion and evaluative considerations (see below).

support to vegetable species of a high ecological significance in order to preserve forest diversity (cf. González Bernáldez et al. 1989, pp. 42-44).

Finally, Bará Temes, et al., advance their conclusion in the very introduction of the CEASA report: “After some years of research and study of the subject, including the analysis of a number of bibliography reviews, one can claim that, at least in the North and Northwest of Spain, positive aspects of eucalyptus overtake its negative aspects, the latter being soluble with adequate planification, arrangement and handling of eucalyptus plantations” (Bará Temes et al. 1990, p. 5).

Eucalypts are here presented as a beneficial option to rural economy, and any possible negative ecological impacts being plainly dismissed or left as an exercise of technological fix.[12] Contrary to the Bernáldez report, Bará Temes Montero de Burgos and Rigueiro Rodríguez do not consider eucalypts ecologically harmful. Actually, the dismissal of its ecological effects depends to some extent on an opportunistic distinction: culture *vs.* forest. Eucalypts are considered by their defendants as a culture. By granting them the same status as corn or bean crops, they allow themselves to use a different set of criteria for the assessment of their appropriateness. Not being a forestry plantation, eucalyptus can no longer compete with the autochtonous forests. Moreover, to define the eucalyptus as a culture is to transform it into an object of exploitation, as a result of which economic considerations take preference over ecological ones.[13]

The real source of disagreement between the CEASA and the Bernáldez report does not only lie in the choice of a definition for eucalyptus plantations, but has deeper roots in the same ambiguity shown by the FAO report. The normative and opposite answers given by both are possible in the light of their antithetical standpoints and value stances, which condition the parameters and information they take into account, and the assessment criteria they handle.

In the case of the CEASA report, the result of this kind of evaluation is thus put in very positive economic terms for eucalyptus: “Eucalyptus reafforestation, wood production together with the commercialization and transformation of its forestry products, create salaries, help to maintain the population in rural areas, and greatly contribute to improving the socioeconomic conditions and the level of life quality in depressed areas and ‘poverty zones’” (Bará Temes et al. 1990, p. 27).

The point at stake here is how to understand and measure such things as the prosperity of an economy, the aesthetic value of landscapes or environmental quality. The impact of eucalyptus on the Asturian economy, limiting now the analysis to economic considerations, can be viewed as positive or negative depending on whether one speaks about short-term benefits or long-term ones, or whether one takes into account the number of jobs or the benefits to industry.

For example, if, following the CEASA report, we only take short-term effects into account, eucalyptus turns into a paradigmatic example of profitability because it does not require much investment and therefore the cost-benefit balance is highly positive. Moreover, its profits are quickly available because it is a fast growing species which reaches a growth of 30 $m^3$ per ha/year. On the other side, if we stress long-term economic effects by following the Bernáldez report, eucalyptus is not such a good business any longer, for some alternatives to eucalyptus plantation (e.g., vineyards in Morrazo – Galicia – and cattle in Llodio – Basque country), in spite of demanding more investment and attention, can be claimed as producing larger benefits in the long-term as compared to eucalyptus (cf. González Bernáldez et al. 1989, pp. 13-19).

The assessment by the CEASA report of the economic impacts of eucalyptus completely differs from that offered by the Bernáldez report even when both assessments are based on the consideration of the same parameter: the number of jobs created by eucalyptus-related industries in comparison to other alternative uses for soil. Both reports coincide on basic and important data, particularly on the assumption that each 19 ha of eucalyptus plantation can create a steady job. This is an assumed fact that they compare with the number of jobs that can be created by other kind of exploitations. The result of this comparison is positive

12. This point is particularly clear in a technical report signed by José L. Montero de Burgos (one of the authors of the CEASA report) and published in 1990 by a Department of the Spanish Ministry of Agriculture (ICONA); cf. Montero de Burgos 1990.

13 The argument that links the eucalyptus to cultures rather than to forests has been quite successful even among green groups, where the use of the expression “eucalyptus culture” has become common. The public administration is also assuming the distinction in its educational materials; cf., e.g., Barroso Díez et al. 1993. Of course, this is a very controversial point, as eucalyptus plantations share characteristics with both traditional forests and conventional cultures.

for eucalyptus in the CEASA report and negative in the Bernáldez one. How can this be so? Simply because, although both cases take into account every job created by the complete cycle (including those of the integrated industry) when assuming the job-generating power of eucalyptus, the CEASA report does not include the whole transformation process in its comparative account of the jobs created by the production sector of quality wood (furniture industry).

To sum up, there are a number of methodological restrictions in the analyses provided by these reports that inevitably affect their conclusions by stressing ecological or economic parameters, different methods of assessment, focusing on specific geographical areas, conceiving eucalyptus plantations as forestry or culture areas, etc. The malleability of the judgement elements and methodological procedures in the work of experts creates the ground for possible alternative interpretations concerning positive and negative impacts of eucalypts. In this sense, experts are not discovering which forestry policy is more convenient from an economic or environmental point of view, but rather political decisions (and eventually value perspectives) are selecting the type of scientific support required for their legitimacy (cf., e.g., Shrader-Frechett 1985, chap. 3; Williams 1991).

## 4.3 The Politicians' Realm

The legislation on eucalyptus reforestation and exploitation will eventually guide institutional action, thus defining an official policy of strong support, general prohibition, or any middle point in between. A broad spectrum of legal measures can be adopted apart from extreme enactment pro or contra, for instance, moratoria and geographical restrictions.[14] The forestry administration will present its decisions to the public as the best legal measures adopted in the light of the best technical expertise.

However, apart from the indeterminacies (and bridging values) acting upon the cogs and wheels of the black box of expertise, the particular legislation on forestry policy is also the result of several factors which usually underlie political decisions: social pressure, political agenda and economic interests, among others. These being different elements, although the same type of mechanism, employed to dissolve indeterminacy within the black box of policymaking. Actually, in our case study, expert advice seems to have been selected to support an already existing forestry policy mainly based on economic considerations.

Nevertheless, diverse policy modifications (partly based on such advice, as explicitly recognized by policymakers) were introduced by law in response to the pressure of a negative public perception. These were important legal steps, at least on paper, openly presented as a major transformation oriented towards solving, by procedural technical means, exactly what the public opinion seemed to demand. But the technocratic implementation rendered a seemingly good legal theory into a democratic failure in practice. Let us briefly consider one of the main legal measures enacted in Asturias at the beginning of the eucalyptus debate and the reality of its application.

In July 1990, and based upon the ground supposedly prepared by a previous zonification bill,[15] Decree 54/90 was enacted and made public. According to this law, whenever a minimal surface unit is surpassed, any project of eucalyptus planting must be submitted to the administration for approval with an enclosed EIA (Environmental Impact Analysis). This was an important legal measure to tackle the social problem of eucalyptus – a provisional and urgent measure accompanied by the promise of a more exhaustive and specific forestry legislation.[16] However, apart from the fact that this measure was, and still is, systematically unfulfilled (especially when plantations are undertaken by individual landowners in small countryside estates, which is the most usual form of eucalyptus reforestation in Asturias), the meaning of the implementa-

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14 As to the broader legal framework – Spanish and the EC – into which the Asturian forestry regulations had to fit, see, e.g., Alonso Olea et al. 2000; Alvarez Baquerizo 2006; Piñar Mañas 2006.

15 In April 1989, the administration made public a zonification bill (estudio de zonificación) in which those Asturian councils not considered appropriate for eucalyptus planting were determined. This bill intended to set non-compulsory guidelines for decision-making at council level. However, its implementation has lacked political willingness and has had no influence at all on council administration. Municipal environment by-laws, regardless of whether elaborated before or after the government bill, contain no traces at all of the autonomic guidelines.

16 Following some unsuccessful attempts by previous governments, the Asturian social-democratic administration began the elaboration of the long-awaited Forestry Programme in 1993. Its general aim was that of trying to make forestry exploitation compatible with other traditional uses of soil, such as the cattle and wood industry. The project also placed special emphasis on obtaining the support of public opinion. The Forestry Programme was not approved by the autonomous government until 2002 (see below).

tion of this decree was also that of transforming an emerging social problem into a technical issue. The mechanism for this transformation consisted in leaving the whole process of policy implementation (project evaluation, consideration of legal complaints, elaboration of EIAs, ...) in the hands of experts, where severe indeterminacy arises again, along with consequent value-solved technical outputs.

Experts act indeed at their own discretion during the process of policy implementation. First, those experts working for the public administration are in charge of project evaluation and lawsuit estimation. Plantation projects, with or without corresponding EIAs, are easily passed, occasionally introducing some minor modifications in, e.g., cutting methods which are too aggressive. In the case of lawsuit estimation, since these are mainly based on the lack of due EIA requested by law, the answer by experts invariably consists of asserting that the project or plantation under legal action does not qualify as meeting the requirement of an EIA. Up to 1993, the justification was that the project had not surpassed the minimal surface unit required by law, a unit which was conveniently determined in each particular case. Once specified the minimal surface unit in 10 ha by the decree 84/92, the need of an EIA is also dismissed by alleging that the project does not represent a danger of serious transformation of the environment. In any case, the lawsuits are usually filed and forgotten.

Second, the EIA process largely bypasses public scrutiny. To begin with, experts under contract by private firms are the only responsible agents for the EIAs production, at least during the first period of the controversy.[17] Construed fundamentally upon a cost/benefit methodology that considers some externalities en passant, our target EIAs embody all the shortcomings of this kind of analysis (e.g. incommensurability of parameters; cf., e.g., Shrader Frechette 1985, chap. 2).[18] Besides a reductive economic methodology, the studies ("a model" in the words of significant administration officials) also contain several kinds of biases and errors: pre-selected bibliography and quoted authorities; contradictions about the vegetal and animal species present in the apparently degraded target areas; benefits assessed only in the short-term; failure to take into account possible alternative uses of the land; arbitrary choices of values for certain aesthetic parameters, ...[19] Moreover, these technical estimations of eucalyptus impacts are largely "urbancentric". For instance, when estimating economic benefits of eucalyptus plantations in standard EIAs, the consideration of individual landowners with small plantations (usually urban population) takes precedence over the consideration of farmers whose harvests are spoiled by adjacent eucalyptus plantations or the rural population who cannot any longer make communal use of those lands now reforested with monocultures. Even estimating the aesthetic value of eucalyptus, the view from roads receives primacy over the view from nearby villages – urban citizens use the road, the rural inhabitant has to live with the reforested hill (cf. PROJARI 1989b).[20] There is no wonder about the final result, provided that one can freely arrange the empirical data under consideration in order to be processed by ready-made methodology.

Once the required EIA is finished, it is sent to the public administration. Its approval is then an easy task (with some occasional minor modifications), especially when there is, firstly, a short period of public exhibition, secondly, no information about the public consulting possibility, thirdly, concealment of the particular values under technical language, and, fourthly, an unclear procedure for lawsuits against the technical study or the contracting firm. The consequence of all this is to leave the application of the law in the hands of experts, which is also a way for private interests to escape from enacted public decisions.

17 Only three EIAs concerning eucalyptus reforestation were issued and sent to the Asturias autonomous administration until early 1994, all of them between late 1989 and early 1990. These EIAs were prepared by PROJARI, S.A. (the assessing company) and presented by CEASA (the cellulose firm contracting the EIAs) to the Asturian public administration, which eventually approved them with some modifications in the original projects. The references are: PROJARI 1989a, 1989b, 1990.

18 A complete discussion of our target EIAs is to be found in López Cerezo/González García, chap. 4; cf. also the Spanish official guidelines at that moment in MOPU 1989.

19 It is just the game in technology assessment and EIA according to Wynne (cf. Wynne 1975), i.e., restricting the possible movements by means of "objective" quantitative rules ultimately serving private economic interests.

20 A similar case, but focused on pulp production instead of forestry policy, is discussed in Richardson et al. 1993. Their target here is a pulp mill in Athabasca, Alberta (Canada), an enormous single-line bleached kraft pulp mill. Analogous to the "urbancentrism" shown in our case study, the authors point out the ethnocentrism which affected the scientific standards for estimating dioxin concentration in fish. Neglecting local knowledge in EIA, experts estimated risks by average fish consumption in the general population, not by the (much higher) average fish consumption in the native Canadian – who also eats fish liver, where toxins mostly concentrate.

Thus, forestry legislation did not solve the social and environmental problem of eucalyptus. The law requiring EIAs was systematically ignored, the EIAs only served private interests, city council officials rarely elaborated regulatory by-laws, and lawsuits by affected people kept on accumulating. Moreover, simply fulfilling the prevailing legislation does not seem sufficient to resolve the original social problem in a satisfactory manner, because indeterminacy and its bridging by means of particular interests and values does not only occur at the level of policy construction, but also at the level of policy implementation. A clear political consequence of this situation is the introduction of technocracy through the backdoor, i.e., the door of policy implementation of a, prima facie, socially sensitive enacted policy. However, there were other social and environmental consequences which interest us now.

## 5 The Transformation of the Socioeconomic System

The action of the government eventually managed to silence, to a great extent, the public debate in Asturias in the early 1990s. After the publication of the 54/90 decree concerning the regulation of reforestation projects, eucalypts were no longer featured as news in the regional press. However, ecological interest groups and affected rural inhabitants have continued their particular battle: a battle that, after the legislation, was not only against eucalyptus, but also against an unsurmountable legal wall.

Indeed, as a result of an inadequate technocratic management of eucalyptus reforestation, a management that disregarded the complexity of the natural and social environment in which the intervention was going to be carried out, a number of transformations in the rural milieu have been pointed out by opponents to eucalyptus, with the help of the expertise provided by green groups.[21] There is, of course, no general agreement on the extent and significance of such interconnected transformations, but, having been broadly echoed through the local media in the late 80s, they are perceived as negative impacts by the Asturian population at large. These impacts consist, on the one hand, in a deep transformation of the natural environment and, on the other, in the entrenchment of specific forms of socioeconomic organization.

The principal factors which, in this evaluation of the consequences of eucalyptus reforestation, contribute to such an irreversible transformation of the natural environment are the following:

a) *Loss of autochthonous flora and fauna*. Many autochthonous trees and animal species in Asturias, some of them endemic, are in risk of extinction. They are simply incompatible with eucalyptus plantations (cf. Lastra Menéndez 2001). Moreover, eucalypts have been the cause of a dramatic increase in forest fires (because of, among other things, the high igneous power of this species).[22]
b) *Pollution by the dependant paper industry*. The massive eucalyptus reforestation of Northern Spain goes hand in hand with the activities of the paper firms – an industry closely related to eucalypts. The production process of wood pulp is highly pollutant, particularly during the whitening stage. In the cellulose industries of our target area, the whitening stage made use of chlorine, and this eventually resulted in extremely toxic wastes being released into the air and water (cf. Greenpaece 1991). In recent years, CEASA (now belonging to the ENCE group) has introduced the less harmful whitening process termed "Elementary Chlorine Free" (ECF), although according to NGOs this new technology does not avoid environmental and health risks.
c) *Transformation of the traditional landscape*. There is concern, based on cultural traditions, that the typical Asturian landscape of meadows and autochthonous forests of oak and beech trees, is being progressively reduced as a result of eucalyptus planting. Up to the present time, this change has been fairly restricted to coastal areas, i.e., the northern half of Asturias, where the frost-free mild weather is particu-

[21] One of the effects of the technification of the debate is that the opponents of eucalyptus have to resort to their own counter-experts in order to defend the soundness of their claims by making them appear more "scientific". Lay people cannot challenge the administration and its official experts without such help. In our case study, this common practice had the effect of transforming popular arguments into more elaborated scientific ones through the expertise provided by green groups (this happened, for instance, in a number of cases where rural inhabitants took legal action against eucalyptus plantations). The relationship between lay people and experts is one of the main concerns in any analysis of public involvement in technology controversies; cf. Brown 1987; Eden 1996; Eden et al. 2006.

[22] At present, Spain is one of the European countries with the highest yearly number of forest fires. It must also be mentioned that a significant proportion of fires are lit on purpose – as consequence of local conflicts on private or public plantations.

larly appropriate to *E. globulus*, although, the more resistant *E. nitens* has been introduced in the last years in inland areas.

d) *General degradation of the environment*. Eucalyptus plantations do not only mean the loss of life diversity and reforested meadows, but they also produce an impoverishment of the soil and affect the neighbouring land in a negative way. The trees themselves create barriers screening off the sun light. Their leaves – very resistant to biological degradation – form a layer which settles on nearby crops. They also use great quantities of available water, and, furthermore, when placed in inadequate locations using aggressive plantation techniques, they favour erosion processes.

In relation to the principal factors which are generally perceived as contributing to the irreversible transformation and entrenchment of a specific social-economic milieu, we may mention:

a) *Cattle abandonment*. Dairy cows have traditionally been the main occupation for Asturian farmers. The traditional policy promoting monocultures such as the eucalyptus, as well as the imposition by the EU of very restrictive quotas upon Spanish milk production, have forced many farmers to change their activities.
b) *Migration to urban areas*. The intense economic growth which took place in Franco's Spain during the 1950s and 1960s produced a massive migration from the countryside to the cities and the appearance of a new economic character: the urban landowner who holds interests clearly in contrast with those of the farmers who have not changed their traditional way of life.[23] Migratory movements to urban areas, on the one hand, and Spanish forestry policy, on the other, actually possess a feedback relationship: mutually supporting and jointly forcing the rural economy to become industrialised.
c) *Changes in the rural economy*, with the disappearance of traditional multipurpose forests such as those of oaks, beech or chestnut trees, which traditionally were for communal use (cattle, wood, fruits, ...). Other traditional harvests are also incompatible with eucalyptus planting.

Of course, all this represents one possible interpretation of the effects of eucalyptus planting in Asturias. Defendants of eucalyptus and many administration officials, with the assistance of their experts, presented a rather different picture of the whole story (cf., e.g., Bará Temes et al. 1990; Montero de Burgos1990), especially in relation to the negative character of the socioeconomic changes.

## 6 The Evolution of the Eucalyptus Controversy

The recent evolution of the eucalyptus problem shows that social controversy is highly resistant to reductive expertise. Far from fully disappearing, the original problem comes to the fore, as the situation is perceived as more and more irreversible by the general population. The political bridging of indeterminacy, and its legitimating use of reductive expertise where lay knowledge is disregarded, has thus resulted in a general destabilization of the social, economic, ecological and political system.

This way, twenty years after the beginning of the controversy, the eucalyptus problem remains open. Although the public debate has never come back with the same intensity as during the late 1980s, it reappears from time to time in the regional media, following the changing political and economic context and the introduction of new regulatory measures. During the last decade, forestry policy in Asturias has undergone a process of democratization, due both to the lessons from the former conflict and to the "participatory turn" that characterizes current European and international trends in environmental policy.[24] The constitu-

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23. Typically, the migrant who left her/his home village behind, in order to try her/his luck in the nearby city, did not usually sell off her/his properties. Generations of family ownership generally create a sentimental value, as well as, of course, the important economic one. Eucalyptus, being a well-known absentee harvest which only requires attention during the periods of planting and cutting, was then seen as the ideal solution in order to obtain a benefit from a property which was no longer cared for daily. Actually, individual landowners who live in the city are responsible for the larger share of yearly eucalyptus planting. They are also the object of the majority of legal actions concerning eucalyptus plantations which have been forwarded to the autonomous administration.

24 The "participatory turn" in forestry policy is shown in the following transnational and national measures: Convention on access to information, public participation in decision-making and access to justice in environmental matters of UNECE (United Nations Economic Commission for Europe), usually known as the Aarhus Convention (1998); Directive 2003/4/EC of the European Parliament and of the Council on public access to environmental information; Directive 2003/35/EC of the European Parliament and of the Council providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment; 27/2006 Act of the

tion in 2000 of the Forestry Council, an advisory board whose members represent the different social groups involved in forestry management,[25] has been a positive initiative, although its functioning in the elaboration of the Forestry Programme has been assessed as unsatisfactory by a good number of the participants. Although the Council discussed the draft of the Forestry Programme and reached consensus on suggested revisions, these were not taken into account in the final version. There have been also criticisms related to the composition of the Council: while some relevant social groups complain about being underrepresented (such as the rural population), others seem to be overrepresented (such as industry representatives). Thus, an appropriate initiative runs the risk of failure if the participatory model proposed is clearly limited in scope or if the participation is perceived to have been made instrumental to a hidden political agenda. As a result, social actors could feel deceived and avoid involvement in the future.

The Asturian Forestry Programme was finally approved in 2002, with a time span of 60 years. Still, this framework needed to be complemented with the Forestry Act, issued in 2004, soon after the approval of the Spanish Forestry Act in 2003. The Forestry Act divides Asturias in ten areas, each one of which should develop its own Forestry Programme. In these processes, the law establishes participatory mechanisms, such as information meetings and diagnosis workshops with involved social groups (cattle breeders, forest owners, users, firm managers ...). Although one of the mottos of the new forestry policy is the restoration of the model of multiple use of the forest and the recovery of autochtonous species, specific regulations are still needed and, in practice, some things have hardly changed.

In relation to eucalyptus, and spite the new framework imposed by the Forestry Act, the situation has remained more or less the same. The extension of eucalypts has been growing uncontrolled in the last years, although some councils have issued very restrictive by-laws to avoid its expansion. The Forestry Programme planned for eucalyptus culture a surface of up to 61,000 ha until 2015. At the time of this provision, in 2000, eucalyptus occupied 52,000 ha. However, regional authorities suspect that this maximum area had already been reached by 2009. In order to know the actual extension of eucalyptus, the Forestry Inventory needs to be updated.

Nowadays, forestry policy has incorporated new arguments against eucalyptus. On the one hand, the global discourse on sustainability in this local context is in tune with the aim of the restoration of the autochtonous landscape. On the other, Asturias has been going through an identity shift: the crisis of an economy based on industry, mining and intensive cattle breeding has given way to an economy based on tourism and services. “Asturias, natural paradise” is the slogan adopted by the government and represents this transformation. The marketing of nature-based tourism is incompatible with the concept of forest cultures, and also requires coming back to the original landscapes and multipurpose forests.

In this new scene, some familiar pictures are beginning to reappear, resignified this time. Eucalypts are being pulled out again, but legally now and with the opposition of the owners: the plantations of E. nitens in the inner lands of Western Asturias (a variety forbidden by the new regulations), and some plantations that invaded the tourist East coast. However, some legal processes remain as ineffective as before: the only plantations pulled out are the new ones, and most owners can preserve their eucalyptus by just paying a moderate fine.

In the middle between the new governmental sensitivity against eucalyptus and the still permissive practice and reality of eucalyptus expansion, a dissonant voice is being heard again: the president of ENCE has asked for more eucalyptus plantations in Asturias in order to relieve the shortage of wood for the paper industry that has to be imported at a high price. But even the language of sustainability has reached the discourse of the paper industry, and the declarations have been implemented with arguments about the value of eucalyptus for biomass production. The reaction of ecologist groups did not take long. The story still goes on.

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Spanish government regulating the rights on access to information, public participation and access to justice in environmental matters.

[25] Council members represent the full range of forest stakeholders, including the autonomous government and city councils, forest owners, industry, agrarian and trade unions, agricultural cooperatives, forestry engineers, university experts, experts in forestry legislation, environmental NGOs and forest agents (cf. Decree 50/2000, BOPA, June 28, 2000).

## 7 The Utility of Lay Knowledge

Political action cannot be legitimised by appealing to reductive technical expertise. There are not "hard facts" – on environmental, economic or socio-cultural aspects – from which the politicians can evaluate the different options offered by experts. The knowledge of local inhabitants about their own socioeconomic system becomes valuable in the face of the indeterminacy of experts' judgement as a new source of information and new perspectives for dealing with given problems (cf. Fiorino 1989; Wynne 1991, 1992a).

In our case study, lay people could have provided at the time *useful information* in the sense that the familiarity of rural inhabitants with their environment makes them a reliable source of knowledge on the effects of eucalyptus. For instance, lay knowledge could have provided information about the economic value for the surrounding community of alternative (e.g. traditional) uses of land, about the ecological impact of fast-growing species in nearby harvests, about their effects on the diversity of life, about the paper industry strategy of actively involving local communities, or about endangered animal and vegetal species present in targeted reforestation areas, etc. All this information was found to be incomplete, or contradictory, or just omitted in the technical reports used as the basis for legislative regulation (i.e., general studies and environmental impact analyses).

Furthermore lay knowledge could have provided at the time *new perspectives* in the sense of showing the importance of the cultural dimension related to the traditional landscape of autochtonous forests which were perceived by the general population as threatened by eucalyptus reforestation. Rural inhabitants could also demonstrate the relevance of communal multipurpose forests in their economy. These might not produce the same global amount of economic benefit as eucalyptus monocultures but they are a part of the communal well-being and are also of importance for a number of services and productive activities within the rural environment, apart from their benefit in the conservation of the natural environment (see above).

Through participatory processes, policymakers could have achieved a better understanding of the social complexity of the eucalyptus issue, being at the same time perceived (by an increasing proportion of the general population) as a cultural threat to traditional woods of oak and beech trees, on the one hand, and considered (by a significant number of urban landowners with small plantations) as a liberation from the countryside life and an economic guarantee to the future, on the other. A common platitude attributes (subjective, pre-scientific) opinions to laypersons while it restricts (objective, rational, scientifically-founded) arguments to experts. However, not only as interested parties, but also as a result of their direct knowledge, concerned citizens at large should have the right to participate in the design and management of the technological and environmental intervention undertaken in their own milieu. Social instability could have been then prevented by means of an earlier and adequate public participation.

However, politicians have eventually recognized some of the ecological and social consequences of such a reductive management which failed to take into account opinions other than those of the experts and factors others than those of an economic nature. On the basis of social criticism and recognition of some of the negative consequences of the previous dynamics, the design of the recent forestry legislation has being carried out by consulting and informing every concerned social group: the Forest Council, rural inhabitants, land owners, political parties..., and even the general population (through an opinion poll). This openness of the process, of course, does not assure the fulfilment of everyone's interests and does not guarantee that the result will be the best possible policy,[26] but it does constitute a first step towards a real participatory and consensual management of a technological system. In our view, this is the only appropriate way of facing the indeterminacy inherent in environmental problems, whose solutions cannot be discovered but rather negotiated among the parties in conflict.[27]

## 8 Final Discussion

For some time now, forestry policy in Asturias has been a sensitive issue that concerns many social groups – laypersons included. Many questions are still open to debate in spite of written legislation. Here one main

26. We have also to take into account that the Asturian experience has shown that socially sensitive political decisions can be a failure if their implementation is not equally sensitive to public opinion. In the case of the Forestry Act, however, criticism does not have to wait until the implementation phase: even the apparently democratic public opinion poll showed itself to be open to manipulation (see below).

27 In the eucalyptus case, for instance, a management which failed to consider the economic interests would be as short-sighted as one which disregards ecological considerations.

question stands out clearly, for which it is not possible – due to unavoidable structural uncertainty – to offer just one and only one answer: Are eucalypts harmful?

To simply look for a scientific answer to this question, and for a technocratic solution to the problem, can be claimed to produce negative consequences of environmental and cultural nature, apart from social instability. Environmental intervention, and technological innovation too, when seen through technocratic glasses, easily disregard the special features of the socioeconomic system in which they are going to be integrated. Instability is then produced when a new element is introduced without taking into account the inherent uncertainty of its behaviour and the complexity of previous equilibrium, that is, when unidimensional solutions are looked for in order to solve specific problems from an economic viewpoint, thereby disregarding any other possible and less visible effects. In the eucalyptus case, the necessity of providing a solution to the economic crisis, and particularly to that of the rural economy, has greatly contributed to presenting eucalyptus reforestation as a simple economic issue. It is certainly an economic issue, but it is far more than that. When public opposition was aroused, and the "ecological problem" came to light, the conflict was left in the hands of experts, and the focus was put on the quantifiable environmental aspects, thus technifying the debate and hence excluding the ordinary layperson. Other socio-cultural aspects were then presented as simple by-products of the technical issue. In the case of the "political problem", the technification of the discussion was used as an artefact to put an end to the social controversy, and as a justification for given political decisions.

Certainly, the controversy originated by the conflict has contributed to the general awareness of the problems at stake, but in a climate of social uneasiness. The exclusion of lay people from the decision-making processes even raised the temptation of shaping of public opinion in order to bring it in line with the interests of the paper industry and the public administration; and this, in turn, has nurtured a lack of trust in institutions.[28] In the eucalyptus controversy, this happened through the opinion poll undertaken in 1994 by the regional government in order to explore the social perception of forestry policy before the elaboration of the Forestry Programme. By a careful selection of the sample, which included only those cities over 25,000 inhabitants and with a significant area dedicated to forestry, the study excluded the population most likely to criticize an excessive emphasis on productivity and fast-growing species (rural inhabitants directly affected by the reforestations, and people who live in large cities with an industrial milieu and scarce forestry, where there is of course more concern for environmental matters). It is not surprising that the poll revealed that only 20% of the sample was in favour of combining the uses of production, conservation and leisure in forestry, while 50% considered that the productive function should have priority.

When mechanisms specifically devised for public participation do not guarantee the fairness of the decision-making processes, special attention should be directed toward assuring the adequate inclusion of the interests and knowledge of the lay population. It cannot be left for the communication media to provide a measure of public sensitivity by highlighting conflicts, or for politicians and experts alone to try to figure out how to solve those conflicts, because this will only increase the risks of manipulation, and lead eventually to the deepening of the conflict. Rather, an appropriate management of technological and environmental issues requires institutional mechanisms of public participation that promote the openness of the decision-making processes.[29]

There is more than one argument in support of active public participation. Structural uncertainty requires openly taking into account as many sources and types of information as possible (including ethical values), and the possibility of "error" morally requires the active involvement of the public at large. Moreover, the familiarity of rural people with the natural and social environment in which they live provides them with useful and detailed knowledge of a full variety of aspects related to the effects of eucalyptus. Lay knowledge embodies new information and new perspectives which might contribute not only to a legitimate environmental policymaking but to an efficient one too. Besides, taking into account public opinion and not only public perception, and thus promoting the active involvement of a variety of interest groups instead of constraining the "social sensitivity" to media reactions and perhaps opinion polls, is important in order to avoid the temptation of some kind of public manipulation through the communication media.

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[28] The relationship between the exclusion of the public and their mistrust in scientific and political institutions is a common argument in the discussion of public participation; cf. Davis 1986; Fiorino 1989; Todt 2003; Wynne 1991, 1992a.

[29] The analysis of the specific political mechanisms for such institutionalization lies beyond the scope of this paper. For a discussion of the different mechanisms for public participation, cf. López Cerezo/González García 2002, chap. 7.

Therefore, being aware of the complexity of the socioeconomic systems in which environmental intervention is carried out, and recognizing the uncertainty that inherently limits the capability of experts to deal with it, requires the opening of the technocratic black box to society. We, of course, do not presume to have the prescription for some kind of alternative truth resulting from a really neutral expertise, whatever this might look like. Our point is that the recognition of the structural uncertainty characterizing the production of forestry expertise and decision-making, as well as the recognition of "domestic expertise" in those lay people affected by environmental intervention, supports the case for open discussion and democratic involvement with regard to the development of environmental policies aimed at the solution of social problems. It is not a matter of eliminating experts' biases but of counterbalancing them in the sense of producing generally acceptable solutions resulting from the intersection of alternatives. Legitimate, and efficient answers, to complex social problems require the participation of society at large.

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# Labs on Stage: Managing Science and Technology without Markets

*Armando Menéndez Viso*

## 1 Introduction

Science and technology (S&T) are almost unanimously acknowledged as two of the main forces shaping our contemporary world – the only caveat to this assertion being that, for many, the two should be treated as just one. The academic study of S&T during the last decades has revealed that these powerful forces are not completely self-driven, but sensitive to social influence. Since S&T are not autonomous, they cannot be abandoned to themselves: they need to be managed. That is why there are science policies through which governments interact with research teams, companies, universities, etc. The will to improve S&T management has placed public participation in science and technology as a goal for politicians, scholars, and activists as well. Allegedly, letting the public participate in deciding how to manage scientific and technological projects should lead both to a more democratic environment and to better decisions on techno-scientific issues. Thus, our societies and our knowledge would improve if channels were provided that allowed lay people to get involved in science policy.

It is well known that these channels may take manifold forms, ranging from consensus conferences or citizens' juries to technology festivals and demonstrations. However, it is usually ignored that, at a conceptual level, these ways of articulating public participation vary significantly, depending on whether the people involved are considered to behave as individuals or as a collective. This chapter shows that the individual approach is tightly linked to linear conceptions of S&T and market models, whereas the acknowledgement of true collective participation in S&T issues leads in turn to collective forms of science making and, consequently, to institutional models.

## 2 Science, Technology and Public Policies

Most science and economic policies appear to be based on the idea that research contributes to increase and ameliorate production through innovation. This seems to contradict Rosenberg's claim that "the linear model of innovation is dead" (Rosenberg 1994, p. 139). It is true that the ordinary version of the model

– Basic research → Applied research → Development → (Production and) Diffusion[1]

has been reduced to a naiveté by the bulk of philosophers and sociologists of science and technology, to the point that virtually any student is told nowadays that such linearity is plainly false. However, if we refer in general to the relation between knowledge and wealth, linearity seems to be alive and well. Indeed, most actual science policies rest on the assumption that investment in science and technology will result in a wealthier economy. One can refine the model introducing a number of intermediate or previous steps, but the basic idea is captured in the following scheme:

– Research → Competitiveness → Market success → Wealth → Wellbeing.

This model has been in the spotlight at least since 1945, the year in which Vannevar Bush completed his famous report, usually seen as the starting point for modern science policy. According to him, "advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live the deadening drudgery which has been the burden of the common man for past ages. Advances in science will also bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited resources, and will assure means of defence against aggression. But to achieve these objectives – to secure a high level of employment, to maintain a position of world leadership – the flow of new scientific knowledge must be both continuous and substantial" (Bush 1960, p. 10). Such an approach was consistent with an old industrialist tradition, fully aware of the importance of "basic" research for improving economic performance (cf. Carty 1916; cf. also Godin 2006). It still is, particularly in the United States, which may be counted today among the followers of this linear model. According to its National Science Foundation: "Science and engineering activities (S&E) are occurring and intensifying in more regions and economies, largely in response to

[1] For a detailed account of the history of the linear model, cf. Godin 2006.

recognition by governments that S&E research and development (R&D) leads to economic growth, employment, and overall social well-being of their citizens" (NSB 2010, p. 1).

The vigour of this "economic" version of the linear model is also apparent in EU policy. The European Commission adopts it literally in its own introduction to European research: "Conducting European research policies and implementing European research programmes is in the first instance a legal and political obligation resulting from the Amsterdam Treaty. The Treaty does in fact include a whole chapter on research and technological development (RTD), so as to underline that RTD is an essential element in the functioning of industrialised countries, such as EU Member States: the competitiveness of companies and the employment they can provide depend to a great extent on RTD; and RTD is also essential for the support of other policies such as consumer protection or the protection of the environment. In short: the individual and collective wellbeing of citizens depends on the quality and relevance of RTD".[2]

It is a widely recalled idea in these times of crisis, that science and technology are forces crucial for economic growth; moreover, science and technology are the basis for economic recovery. This argument tunes in perfectly with solid economic theory (cf., e.g., Rebelo 1991), which links knowledge (particularly in the form of science and technology) and wealth. No wonder, then, that financially troubled governments, companies, and individual citizens turn now to science and technology in search for help. From this viewpoint, it seems quite natural to steer S&T policies so that they lead the vessel of the state to the greatest possible profit. Thus, in its webpage about the IV Conference on the FP7, held last April in Valencia, under the Spanish presidency, the EU stated that the "European Economic Recovery Plan seeks a new deal on vital new and traditional industrial sectors in order to foster economic growth and creation of employment, as well as maintaining our high standards of quality of life. Knowledge, technology, innovation and new markets have complementary roles for reaching these goals".[3]

However, it is too easy to slip into a *non sequitur* and come to think that wealth should be the ultimate end of scientific and technological activities. If we are to judge by the way science and technology are managed nowadays, we should conclude that this mistaken consequence is all too often drawn. Indeed, science policy seems to be increasingly oriented by economic benefit. Given the context, there are good reasons to excuse science policy makers for erroneously drawing this profit-oriented strategy from economic theory. When assessing science and technology, it is almost impossible to get rid of economic instruments, precisely because economic ends are often behind scientific research. This is not to say that economic forces surreptitiously govern science, or that scientists surrender, consciously or unconsciously, to spurious economic interests. This is to say that economic targets and scientific goals tend to converge, many times in a very positive way. Thus, when a research team is working on a vaccine against a human disease, or designing a more efficient engine, or developing a plague-resistant crop, they are also achieving economic ends (say, longer life expectancy and fewer work hours lost, lower costs of production and maintenance, higher productivity...) and, therefore, the outcome of their work can be properly analysed in economic terms. In these terms, S&T are also (if not only) seen as part of an economic enterprise, in which a number of players are involved.

Consequently, it seems quite natural to manage techno-scientific products (theories, research projects and teams, drugs, new materials, tables, methods, machines, concepts, research departments and institutes, etc.) using market mechanisms like monetary incentives (e.g. prizes or grants), tax benefits (for research institutions or companies investing in R&D), advertising (in a literal sense, but also understood as popularisation of S&T products or transparency in competition for public or private funds), competition rules (patent system, copyrights, criteria for funding or employment, ...), and so forth. S&T governance would only be widening the S&T scope and lubricating its machinery, mainly by, as in perfect markets, preventing abuses and supplying participants with all the relevant information (for instance, through experts panels or participatory assessment), so that everyone knew exactly what was on sale and could freely decide whether to purchase it or not. In other words: when the linear model of S&T and the economy is accepted, the aim of S&T (good) governance is that every relevant agent know what to expect from a given research project or product and, thus, freely decide whether to go for it or not. For "social agents" (decision makers, stakeholders, citizens, patients, etc.) "going for it" means funding it, supporting it, or simply stop protesting against it; for "scientific and technological agents", it means starting or continuing to work on their projects, building their devices, experimenting, producing and selling their gadgets, etc.

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2 http://ec.europa.eu/research/index.cfm?pg=why.
3 http://www.r2sconference.eu/, as of May 1, 2010.

But is that all there is to S&T governance? Is it just a matter of regulating exchanges, mainly by rendering information visible, so that every one is better off in the end? Is the public just another customer or seller to be taken into account? Before moving on to tackle the question as to how the public may partake in S&T management, it is necessary to clarify what "public" means.

## 3 The Problem of "the Public"

Proponents of public participation base their arguments on a causal chain very similar to the linear model

- Public participation → Better S&T and Society → Wealth / Wellbeing.

The double character of the second link of the chain gives rise to two different arguments for public participation: "political" and "technical". The political argument states, in short, that public participation in science and technology reinforces democracy and strengthens society. The technical argument claims that involving more people in decisions about science and technology would make these decisions wiser. In the words of the most used manual for public participation in science and technology, the political argument turns into a normative line of argumentation, whereas the technical argument becomes a pragmatic reason: "Demands for increased public participation in policy-making have been founded upon pragmatic and normative lines of argumentation. From a pragmatic perspective, participatory processes in policy-making are considered to address problems such as lack of trust among the public for governance institutions and perceptions of weak legitimacy. From a normative point of view participation is necessary to render the decision-making process more democratic. New problems and issues in society often pose questions for which existing social norms are inadequate or non-existent, creating uncertainty and anxiety in the society. In addition, the plurality of (often conflicting) norms in a society is often mixed up with interests (financial or otherwise), which are unequally represented in society. It is thus normatively desirable to enable a process that is as democratic as possible in order to ensure that all values and opinions can be represented in a policy debate" (Steyaert/Lisoir 2006, p. 10).

Remarkably, both arguments take it that science and technology could manage well on their own. Public participation only makes them better. That is why public participation requires argumentation. Indeed, if public participation were as necessary for research as laboratories, journals or electrons are, there would not be any need for defending it. But defending it against what or whom? Apparently, public participation must be defended before scientists, governments, industrialists, and other agents who are actually used to managing research without it. Therefore, public participation is treated like an alien to techno-scientific activities: it comes from the outside and asks to be accepted inside. There are two strategies to let the public in, corresponding to two different concepts of "the public".

The public can be understood either as a mere set of individuals, formed by aggregation, or as an autonomous whole, whose intentions are shared by each of its parts and therefore able of acting as a proper, single agent and not just as a sum of them. Depending on which concept of public is used, the idea of public participation varies significantly, and has to confront different problems. If the public is taken as an aggregation of individuals, then public participation means bringing individuals into S&T management (into the S&T collective), thus breaking the external situation of "the public", but dissolving it as a group. If the public is considered a proper collective, then it has to be confronted with other collective members of S&T (such as governments, research institutions, companies, and the like), or with S&T as a whole – taken as a collective itself. But then public participation seems to remain a mere external influence.

## 4 Individualist Solutions

Individuals are accepted to vote, argue or bargain in S&T related questions, while keeping the asymmetry between "experts" and "lay people" – since they participate as "external" individuals, with their own interests, education, professional activities, etc. The European Science and Innovation Citizens Agenda project constitutes a vivid instance of how linearity combines with individual, external participation. The EU has very recently launched[4] this initiative with the aim of allowing "European citizens to tell the heads of science and innovation in Europe what challenges they consider to be most important and that should be solved by 2030 in the areas of science and innovation". The Agenda selects 14 European, scientific "celebrities" that "changed our lives" thanks to their inventions or discoveries. These public figures include the

[4] April 22, 2010, to be precise

architect Norman Foster, the biologist Jane Goodall or the physicist Juan Ignacio Cirac, as well as the creator of the Erasmus grants, the inventor of the mp3 or the main contributor to SMS technology. For a month people are allowed to vote on a website for the challenge that they consider most important, there being good prizes for the participants. An electronic marker in the hall of the European Council in Brussels adds up the votes "in real time" until the end of the voting period.[5] Curiously enough, the results of the voting will not be presented at a meeting on science policy or on research, not even at a conference on public participation or democracy enhancement: they are going to be announced at the European Council on Competitiveness.

A successful instrument for promoting citizens' participation has been the creation of normative frameworks, in which common people's actions may alter S&T members' actions, as done in auctions, games, and similar contexts. Governance of S&T can be thus represented as the rules for a strategic interaction, in which stakeholders, companies, scientists, patients, neighbours, technicians, policy makers, ..., and members of the public in general act as individual players, in such a way that each one is able to defend their own, well defined interests and preferences. Game-like models are probably the most common way of representing the relation between the public and the non-public when it comes to science and technology. From this perspective, the public is another player that should be brought into the game, but this can only be achieved by convincing those who were already playing that the new participant would add interest to the game. Governments and supranational institutions make good efforts to convince actual players: "The SET-Plan must stem from a shared and inclusive European vision, involving all relevant actors: industry, the research community, the financial community, public bodies, users, civil society, citizens, unions. It must be ambitious in setting targets, but realistic and pragmatic regarding resources. While avoiding being perceived as a European level 'picking winners' approach, the SET-Plan will have to be selective – 'different horses for different courses' – ensuring that the right portfolio of technologies is brought forward to enable Member States to pick and choose the appropriate combination for their preferred energy mix, indigenous resource base and exploitation potential" (EC 2006).

There is nothing wrong with aggregated, individual participation. Nonetheless, from the individualistic point of view, public participation does not take place *in* science and technology, but, at best, reflects *on* it. If participation comes really from the inside, it is not public; if it comes from the outside, it is not participation, but assessment, control, paternalism, or something similar. The EU may declare that public control is public participation *in* S&T ("The Programme should contribute to looking at civil society not as a constraint but as a driver and locus for innovation and therefore an active player in building a democratic knowledge society" – EC 2007), although declaring something does not make it necessarily true. Individual citizens can modulate or limit S&T, or at best exert a kind of libertarian paternalism on it, by "nudging" S&T makers – to use the now famous expression proposed by Richard S. Thaler and Cass R. Sunstein (cf. Thaler/Sunstein 2008).

For many, this would be good enough, since establishing its democratic limits and controlling its development already makes S&T better. Markets and games are excellent mechanisms for creating and regulating strategic relations between individuals. They can explain, predict, and regulate individual behaviour, sometimes even with astonishing accuracy. Individuals participate in markets and games because their decisions alter them (it could be said that these decisions *make up* the market or the game). But from this point of view, scientists and other 'internal' agents would tend to see members of the public more as opponents (if not intruders or plainly obstacles) than as proper partakers. From the individualist perspective, there can be good S&T without any public participation, as there are markets without regulators. Citizens cannot be full members of the S&T enterprise unless this is redefined to accommodate them as indispensable elements. Is there any model in which public participation appears as necessary, and not only as something politically or pragmatically convenient?

## 5 Collective Solutions

Science and technology studies have been telling us for the last few decades that scientific outcomes are agent-dependent. Scholars tend to assume that this dependence is of the form "each depends on many". However, it is also possible that "each depends on all" (Elster 2007, p. 299); i.e., that S&T be a proper col-

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[5] Cf. http://www.eu2010.es/en/documentosynoticias/noticias/abr22_agendaciencia.html. As these lines were written, the voting period had not yet begun.

lective enterprise. This seems particularly likely if we take authors like Ian Hacking seriously and consider S&T to be activities, and not mere sets of "things" – be they theories, books, instruments, laboratories, etc.

If the public is outside S&T, when it acts inside, it interferes. When inside, it should share at least some intentions with scientists, technicians, etc. If we are to conceive public participation as interfering, we need to place citizens hand in hand with scientists and other S&T members. Of course, it would not be sensible to claim that citizens should be incorporated to, say, laboratories to tell scientists how to do their job. The point is to bring both together to a scheme in which they share the job, in which they share common intentions and goals. But this means assuming collective intentionality, which is far from unproblematic.

According to Raimo Tuomela, a collective is roughly defined as "a collection of persons to which we ordinarily attribute interests and goals and which we also assume to be able to act in a goal-directed way. Specifically, groups to whose members we attribute group-intentions must also be assumed to be self-conscious: the members (or their majority) think of themselves as members of the group in question and tend to use the pronoun 'we' to refer to it" (Tuomela 1991, p. 251).

Group intentions require that groups cannot be reduced to mere "collections" of individuals. Collective intention is the intention of the collective, not the average intention of its members, or anything similar. Irrespectively of the mechanisms used to set up that intention (arguing, bargaining, voting or a mix of some or all of them, according to Jon Elster; cf. Elster 2007, p. 403), once it is there it is just one, belonging equally to any member of the group – precisely and solely because of being a member of that group. If we are playing basketball in the same team, we all have the same collective intention (play to win according to the rules of the game), besides or apart from our own individual intentions (glory, fun, money, ...); if we sing in a choir, we all have the same collective intention of performing the piece at our best, no matter what we are or do before and after rehearsals and concerts. The origin of their members is perfectly irrelevant for music ensembles and sport teams. The only important thing for them to exist and succeed is that their members actually play, and do it well. A collective needs their members to act as it demands (in a "we-mode", to use John Searle's expression): if individuals look for their own intentions and goals and put the collective objective aside, the collective simply ceases to work. A rugby player seeking to score a try by himself would ruin her team, just like a musician trying to stand out on her own would be disastrous for an orchestra. Collectives are defined by their action, by their function. According to John R. Searle: "1. Whenever the function of X is to Y, X and Y are parts of a *system* where the system is in part defined by *purposes, goals and values generally*. This is why there are functions of policemen and professors but no function of humans as such – unless we think of humans as part of some larger system where their function is, e.g., to serve God. 2. Whenever the function of X is to Y, then X is *supposed to* cause or otherwise result in Y. This normative component in functions cannot be reduced to causation alone, to what in fact happens as a result of X, because X can have the function of Y-ing even in cases where X fails to bring about Y all or even most of the time. Thus the function of safety valves is to prevent explosions, and this is true even for valves that are so badly made that they in fact fail to prevent explosions, i.e., they *malfunction*" (Searle 1995, p. 19).

On the other hand, proper collective actions are impossible for individuals: a single player could never play a football match, and a solo singer could never perform Victoria's *Missa "Vidi Speciosam"*. The challenge for the collective conception of public participation is building up collectives in which experts and laypeople act together and perceive themselves as mutually dependent to achieve a common goal. The model to create such collectives might be the theatre, understood as a collective enterprise defined by the following features:

- On stage, all actors and actresses are equally indispensable to perform the play; and not only actors: also the author, the director, engineers in charge of lights and the machinery, carpenters, costume designers, dressmakers, prompters, managers, hairdressers, make-up artists ...
- Such equality requires an artificial and provisional context. Performances have their beginning and their end: they are not permanent.
- They should provoke a catharsis; i.e., they should be able to move people's minds or, in other words, people should not take part in them as in bargains, where everyone defends their own interest. Spectators and actors should leave their individual worries aside.
- Performances are open to public scrutiny (in fact, they are created for the public). Apart form the actors, there are spectators that attend more or less passively, and then clap or protest. In the markets there are no spectators – and, if there are, they are not a part of the market. At the theatre, the public is a part of

the business, its *raison d'être*. The governance of S&T should take place before the public (a "passive", external public, not the citizens who eventually are participating in the play).

Are there any actual instances of this model? There are: associations, NGO's, civil movements, ... All these institutions are able of gathering scientists, activists, common citizens, politicians, victims, etc., in pursuit of a common goal. In these associations, people do not exert any influence from the outside, but make up a necessary, active part inside. The public, by definition, remains outside, watching, while scientists integrated in the collective may be as expert as amateurs. However, this means that "the public" does not participate in physics, chemistry, nanotechnology or computing. Collectives cannot be built on a disciplinary basis, but on action. Hence, there is no participatory mathematics or biology, but public participation on things like nuclear waste disposal, intellectual property definition, social security systems, medical treatments, and so on.

An interesting side effect of this collective conception is that, conversely, S&T should take part in deciding about public issues. "Political" decisions should use mechanisms similar to those built to facilitate public participation in science and technology. This does not only mean calling experts to parliaments or political bodies, but also creating new bodies, in which both political representatives and science and technology professionals could debate and take decisions together. Just as S&T don't need further opinions from the public, decision makers should not treat experts like one more opinion, on which to base their decisions. "Experts" should also be decision makers, just like "the public" should be involved in the creation of S&T. "Besides this pragmatic and normative perspective, there is also a line of argumentation that relates directly to content. It is better to have as much knowledge, experience and expertise as possible in addressing the complex (and thus uncertain) nature of societal issues and problems. The means to have institutionalised and/or informal influence on decision-making processes are unequally distributed among members of society. Therefore, access must be created for all relevant persons to contribute to solutions and planning for the future" (Steyaert/Lisoir 2006, p. 10).

## 6 Concluding Remarks

Public participation *qua* public can only take place from the outside and proper participation can only involve individuals. But once individuals join together in a techno-scientific action, they can act collectively and therefore aim at non-scientific, non-economic goals – taking into account both S&T and the economy. We should therefore foster either individual participation in S&T through usual game theory, nudge, etc., or the constitution of proper collectives through institutions aimed at solving well defined problems (the theatre model). Hence, the task is not enrolling the public, but rather dissolving the frontiers and creating functional collectives (made up of various agents – scientists, technicians, and lay people among them) to tackle political challenges (in the widest sense of the term), which require the use of S&T. The public is more accustomed to be involved in deliberative processes than scientists and technicians. The problem is not to bring people into science and technology, but to bring S&T into the theatre-like schemes applied to public participation; i.e., to call labs on stage.

Calling labs on stage does not mean making them observable and controllable to the lay public, as if we were to create a sort of Latourian "Big Brother". It rather means that scientific and technological tasks should be conceived of as a play, as something that could be performed in front of the public by manifold actors, and – this is the key – as a plot aimed at an intended end, as a collective work consciously oriented towards a collectively established target. In order for a proper public participation to take place, collectives that integrate S&T are required. Otherwise, we would only have control mechanisms or, alternatively, private participation. Individual solutions can be more efficient in some cases, but only collective models render public participation necessary.

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# Evaluation: Tool for Policy Design or Brake for Reform? Anthology of the European Commission's Research Evaluation

*Gilbert Fayl*

The issue *is evaluation a tool for policy design or brake for reform* is addressed in the context of the European Commission's research evaluation.

The conclusion is that it could be both, depending on a plethora of factors and circumstances. In 1994 new legislation obliged the European Commission to enhance its research evaluation relating to joint European research and technological development activities. In response to this, the Commission services made every effort to comply with the introduced legislation and minimize potential conflictual situations with legislators.

The author actively participated in the process during this challenging phase. He headed the European Commission services responsible for the initiation, elaboration, introduction and implementation of the then novel evaluation scheme.

This paper is based on the author's long hands-on experience in the complex European research environment. But its findings and conclusions have validity when dealing with research supported by public funds.

The paper expresses the author's own views and opinions, and describes the situation until the end of 2009.

## 1 Preface

Scientific research is a driver of progress. Legislation helps ensure adequate conditions. Formulating legislation, including allocating public funds, is a complex process. Credible political decision-making requires reliable scientific advice. The necessary trustworthiness comes from scientific research and its evaluation.

There are potential conflictual situations in the interfaces between legislators / researchers / evaluation:

- Legislators have a limited duration of mandate and operate with restricted public funds. They require immediate results, often long before these can be delivered.
- Researcher, in turn, prefer to take a longer-term view and are inclined to disregard constrains such as limited public funds.
- Evaluation, when placed in a rigid procedural framework, is unable to deliver a timely response to developments. Evaluators, when biased, will reduce the value of advice.

Scientific advice based on evaluation of questionable quality may well delay political decision-making. In the worst case, it could be a justification for no-decision.

Conflictual situations with decision-makers are always possible. Every effort must be made to produce evaluation of highest quality and professional integrity. Solely trying to please legislators and hierarchy, or fellow scientists, is treacherous against taxpayers and professionally immoral.

## 2 The Issue: The Battlefield

Scientific research is a driver of progress. Research requires funding. The latter may be a source of potential conflicts between researchers and fund providers.

The essential principles of conducting high-quality research with public funds are straightforward:[1]

- find the best qualified researchers;
- provide them with adequate funds;

[1] Paraphrased by the author after Bromley 1994; Bromley was the Science Adviser to US President George H. W. Bush from 1989 to 1993.

- let these researchers do what they think represent the best use of their intelligence and time, while respecting fundamental ethical principles.

Underlying this approach is the concept of societal investment rather than political procurement. In an ideal world, this approach might best serve the long-term interest of society. In reality the process is complex rather than straightforward.

Obtaining public funds for research happens in a *"battle-field"*. The two main actors enter with different presumptions and objectives. On the one hand, researchers possess a certain degree of "political naivety". They are ready to ignore constraints that are dictated by political realities, such as limited public funds. In turn, politicians often demonstrate "scientific ignorance" due to their inadequate scientific background. In addition, politicians operate with a different time horizon – the date of their mandate's expiration hangs above their heads like a Damocles sword.

Additional complexity is introduced by the ever-increasing awareness of civil society and its various pressure groups demanding societal return for public investment. In the context of the European Union (EU), forces stressing long-term social investment for sustainable European development often clash with those focused on shorter-term needs and narrow national interests. The outcome of this process is not easily predictable. The environment simply does not lend enough transparency. Funding requests must be supported by convincing arguments and articulated with gravitas. This includes, above all, the concept of the value of European co-operative research, i.e., "European value-added"

Evaluation[2] is indispensable to formulate scientific advice and convincing arguments. But evaluation in itself may very well be the source of conflict. Evaluation of questionable quality could delay decision-making. In worst case, it could be used as a plausible justification for no-decision.

# 3 The Reality

Many forces are interacting during the process of allocating public funds. Within any given legal framework and budget constraint, the ambitions and intellectual might of politicians together with the relative importance and influence of lobbying bodies are the principal determining factors for the final outcome.

In this multifaceted, and sometimes quite antagonistic environment, it is often not easy to anticipate the outcome.

## 3.1 Struggle for Funds

The debate in connection with the finalisation of the Seventh EU RTD Framework Programme on the overall multi-annual EU budget presents an illustrative example of the struggle for public research money. The financial perspective proposed by the European Commission in April 2005 for the period 2007-2013, and subsequently supported by the European Parliament, was severely cut by the European Council in December 2005.[3]

The Commission's proposal was based on global socio-economic reasoning and considered a wide range of scientific advice. The scientific input had taken into account both evaluation of current and previous EU research activities as well as assessment of the need for continued European research. By contrast, narrow national interests dictated the Council's position.

The author's assessment (cf. also Fayl/Nagy 2006) of this striking conflict between politics, and scientific advice and evaluation is given in Annex B "Conflict between Politics and Scientific Advice". The outlined

2 Unless otherwise stated, the word "evaluation" is used in a more general meaning in this paper, including its title; cf. also Annex A "Definitions Relating to Research Evaluation", at the end of this article.

3 The Brussels based European Policy Center commented the decision of the European Council as follows: "Given the competitive gap opening up between the EU and some of its major global competitors, the Union should be ready to put far greater resources into research and development, energy supplies and knowledge economy generally. This implies a budget significantly larger than the agreed total of 862.3 billion Euros – just 1.045 % of EU output. The actual outcome was not just well below the levels pressed for by the European Commission and the European Parliament, but is also inadequate when measuring against the need to boost areas already mentioned, including EU-wide investment in research, development and innovation […]" (December 19, 2005, EPC, Brussels).

developments illustrate how real politics may ignore even the most clearly formulated plausible arguments. They simply might not be sufficient to outweigh the pressures dictated by interest groups – be they local, national or beyond. The scientific community must accept and face this situation. Various lobbying mechanisms of the scientific community are increasingly becoming aware of this reality and making their voice heard in the EU environment. This is where making allies in the European Parliament can be helpful.

## 3.2 Scientific Advice

In order to respond to evolving global challenges, while moving towards more democratic governance, public authorities are increasingly paying attention to scientific advice. The latter is understood as "value added guidance deriving from scientific theories, data, findings and conclusions provided to inform policy and regulatory decision-making" (SAGE 1999, p. 1).

Scientific advice is becoming central to an increasing number of decision-making stages (cf., e.g., Fayl et al. 2003). From policy design to policy implementation, decision-makers have to increasingly rely on scientific knowledge. This in and of itself poses new challenges to the development of democratically acceptable methodologies for production and implementation of scientific advice. According to Sir Robert May, former Chief Scientific Advisor to the UK Government and former President of the UK Royal Society: "Advances in science and technology […] have happened so rapidly that governments the world have been […] left scrambling to make policies in a context of scientific uncertainty and vociferous public opinion" (May 2000).

Taking into account the complexity of most scientific issues and their interdisciplinary nature, access to appropriate knowledge becomes increasingly challenging. Collecting such information takes both time and necessitates adequate funds and a variety of competences. Such necessary resources are not easily available.

In this multifaceted process, quality evaluation is a powerful means to substantiate expert advice.

# 4 Research Evaluation

External independent control on the use of public funds is an essential feature for democratic governance. It helps guarantee the transparency and efficiency of the decision-making system. It is also an important tool to manage, plan and optimise the best use of public resources. Within this context, evaluation fulfils a number of functions – ranging from assisting political decision-makers right to the researchers themselves.

But there is no single best solution that can be applied to all situations. Trustworthy evaluations are carefully tailored to individual circumstances. Even so, it is not always easy, if not impossible, to avoid conflictual situations (see Chapter 4.2 "Inherent Conflicts").

## 4.1 Optimal Conditions

Research evaluation realises its full potential only when it is a part of a dynamic management system where:

- Adequate means and resources (financial and otherwise) are available to carry out evaluation.
- Clear objectives and strategy guide the actions to be taken.
- The system has adequate inherent flexibility to respond to changing circumstances.
- Self-evaluation and monitoring is a part of daily management.
- Evaluation is a part of broader management culture and is not considered as an additional level of bureaucracy.
- The evaluation experts are independent and unbiased.
- The experts' opinion and recommendations are published together with management's response.
- The system has a clear strategy for dissemination of results obtained and experience harnessed.

An evaluation report must not contain dubious statements. These reduce the credibility of the exercise and could create unnecessary conflicts.

## 4.2 Inherent Conflicts

Potential conflictual situations are inherent in all public governance. Formulating legislation, including allocating public funds, is a complex process. The need for scientific advice is indisputable. The necessary trustworthiness comes from scientific research and its evaluation. But there are potential conflictual situations in the interfaces between legislators, researchers and evaluation. Legislators have a limited duration of mandate and obliged to operate with restricted public funds. They require immediate results, often long before these can be delivered. Their time horizon rarely goes beyond the end of their mandate. Researchers, in turn, prefer to take a longer-term view and are inclined to disregard constraints such as limited public funds.

Evaluation, when placed in a rigid procedural framework, is unable to deliver a timely response to developments. Evaluators, when biased, will reduce the value of advice. To set this in the context of EU research activities: in certain scientific fields it is becoming increasingly cumbersome, if not impossible, to identify experts who are fully independent while possessing sufficient scientific knowledge required to carry out high-quality evaluation. The factual issue is that researchers are increasingly intertwined: could an expert at all evaluate a fellow scientist in one field while sharing research with him/her in another? This is an ethical question that needs to be dealt with on a case-by-case basis.

Other issues that might be a source of potential conflicts are the focus and time-scale of evaluation: should the focus be on broad and immediate outcomes or on more long-term results?

Moreover, conflicts might arise from disagreement concerning the aim of research evaluation. Should it primarily be a fund allocation instrument as an element of budget control mechanisms? This is certainly the opinion of some short-sighted politicians and many bureaucrats, who do not always grasp the distinction between evaluation and audit. This is the "play-safe-approach". Or, should the aim be to assess research quality and long-term societal impacts? This is the "value-for-money approach". In the current debate about future EU research funds those who support the latter position are becoming increasingly visible and vocal. Regretfully, during political negotiations behind closed doors those who have taken the former position often have the overhand.

It can only be hoped that the struggle between the proponents of these two juxtaposed approaches will eventually not deteriorate scientific evaluation to pure budget control. However, one must not underestimate the fact that it is in the interest of some decision-makers to hide their narrow short-sighted positions behind the "play-safe-approach". Recent experiences with the future multi-annual EU fund prospects (i.e. EU 2007 – 2013 Financial Perspective) are disturbing.[4]

For those who are responsible for research evaluation it is not always possible to keep away from conflictual situations. But shying away from possible conflicts with hierarchy and / or decision-makers must not compromise the quality of evaluation. In the long-term, this serves nobodies interest. On the contrary, such an approach is fundamentally against the interest of taxpayers and fellow scientists.

All those who commission, carry out evaluation, or use its outcome must understand this. Every effort must be made to produce evaluation of highest quality and professional integrity, respecting ethical standards. It will be all too simple to disregard the question of evaluation quality. Even worst, not up-to-standard evaluation may eventually be counterproductive and delay political decision-making.

In the worst case, it could be a justification for no-decision.

# 5 Tool for Policy Design

Within the European Commission, research evaluation has been carried out against the background of the considerations discussed in the former chapters (cf., e.g., Durieux/Fayl 1997). In addition, the evaluation scheme implemented has taken into account the specificities of EU research.[5]

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4 Cf. Annex B "Conflict Between Politics and Scientific Advice", at the end of this article.

5 The EU research is guided by certain criteria, including scientific excellence and European value-added. The research is organised in two Framework Programmes (non-nuclear, nuclear), each containing several Specific Programmes. Each of the latter contains numerous research projects. Industry, research organisations and universities execute jointly projects. As a rule, individual projects are carried out simultaneously in more than one country.

Research evaluation has been used by the Commission services for some 30 years. Since the early 1980's a dedicated unit in the Directorate General Research (then called DG XII) has co-ordinated and supervised this evaluation.

## 5.1 Credibility Concern

By the early 1990s, it became clear that the existing evaluation scheme had serious shortcomings. It was frequently impossible to translate the outcome of evaluations into appropriate input necessary for managerial- and political decision-making. Several reasons for this shortage were identified:

- Lack of overall synchronisation: evaluation exercises had not been adequately correlated to decision-making processes.
- Insufficient indicators: an appropriate set of common indicators had not been systematically collected.
- Inadequate time-frame: results had not always been examined in an appropriate time-frame to enable useful interpretation.

The credibility of the scheme was rightly questioned. After a period of reflection by both decision-makers and the Commission services, a considerable development has taken place from the mid-1990s onwards. The research evaluation scheme has been streamlined across the entire Commission. Eventually, it has matured and evolved into one of the most comprehensive evaluation schemes employed anywhere (cf., e.g., Fayl et al. 1998).

The author and the *Evaluation Unit* under his responsibility had been charged to develop the new scheme and get it accepted by the various Commission services and eventually its hierarchy. This presented considerable challenges. There was no known-scheme that could be directly implemented for the EU conditions. Moreover, mobilizing a large and complex bureaucracy and influencing mind-sets away from routine procedures turned out to be cumbersome although professionally rewarding.

But there were also bright intellectual moments.[6]

## 5.2 The Turning Point

The legislation of the Fourth EU RTD Framework Programme[7] in 1994 was a major turning point. This legislation necessitated a more thoughtful and focused evaluation scheme than had been previously used. As a consequence, further attention had to be placed to efficacy, efficiency and effectiveness as well as relevance.[8]

The Commission services made a concerted effort to comply with legislative requirements and thus eliminate potential conflictual situations with decision-makers. After considerably effort, an improved evaluation scheme was developed based on the following main principles:

- *Full democratic accountability*: strict adherence to legislative requirements, including responding by the Commission to recommendations formulated by expert evaluators.
- *Full transparency*: complete openness in the procedures and operation including the choice of independent experts and involvement of relevant stakeholders (participants, various comities, Commission services, etc.).
- *Strict independence of evaluators*: avoiding conflict of interest, thus continuing the involvement of independent external experts.
- *Appropriate frequency of exercises*: major evaluations with regular intervals and reports issued in time respecting the need of decision-makers.
- *Better harmonisation across individual research programmes*: harmonised core indicators (input, performance, output) and, as far as possible, similar evaluation schemes for the individual research programmes.

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The EU and participants share the necessary finances. The European Commission services ensure the overall co-ordination and management.

6 The author as well as together with colleagues has published numerous scientific papers in the open literature.

7 Decision No. 1110/94EC "Fourth Framework Programme of the European Community Activities in the Field of Research and Technological Development and Demonstration (1994-1998)".

8 Cf. Annex A "Definitions Relating to Evaluation of EU Research", at the end of this article.

- *Appropriate interaction*: due involvement of all relevant stakeholders (experts, project participants, programme committees, Commission services, etc).

The above rationale led to a new evaluation scheme that has been successfully employed for several years.

## 5.3 In a Nutshell

In agreement with legislative requirements, the new evaluation scheme was based on two main elements for each programme:[9] (1) continuous monitor and reporting annually, and (2) a five-year assessment mid-way through implementation. The output of successive annual monitoring provided important elements for five-year assessment. The latter combined an ex-post evaluation of previous multi-annual programmes, a mid-term appraisal of ongoing ones, and recommendations for future orientation of research. As successive Framework Programmes have overlapped by one year, there was full continuity in the evaluation process.

The monitoring and five-year assessments were carried out for all Specific Programmes in parallel, so that their output was available in a synchronised fashion. The latter enabled a thorough evaluation at the Framework Programme level. Thus, the five-year assessment produced constructive input in time for negotiations by the Commission with the relevant other European institutions.

Panels of independent experts, who combined a multitude of relevant scientific- and evaluation experiences and cultures, conducted the above exercises.

The resulting reports contained the experts' opinions and recommendations together with the Commission services' responses to the latter. Eventually, the reports were transmitted to all related bodies, i.e., programme committees, relevant European bodies (Council of Ministers, European Parliament, Economic and Social Committee, Committee of Regions), scientific community, etc.

## 5.4 Mobilizing Allies

It has been of great value that external experts have participated in the evaluation exercises. With their help, the *Evaluation Unit* was able to keep itself at the forefront of methodological development. In turn, if needed, the experts could give evidence of the soundness of Commission's evaluation scheme.

In addition to the experts, the following structures have assisted the *Evaluation Unit* to mobilize allies in the Member States and within the Commission services:

- *Evaluation Sub-Committee of CREST* (Scientific and Technical Research Committee, a Council body) composed of representatives of Member States central administrations. Here, the author represented the Commission services. The Committee has met a few times a year in order to provide critical views on methodological aspects related to evaluation of EU research programmes and associated work of the Commission services, and to suggest constructive proposals for improvements.
- *European RTD Evaluation Network* composed of outstanding evaluation experts, one from each Member State. The Evaluation Unit took this unique initiative; the author chaired the Network that has met twice a year (in the Member States holding EU Presidency). The Network discussed methodological issue.
- *Inter-Service Group on Monitoring & Evaluation* composed of representatives of relevant programme directorates within the Commission. Also here, the *Evaluation Unit* took the initiative and the author chaired the Group. The Group has met regularly to discuss how best to implement evaluation related legislation. In order to facilitate the Group's work, the *Evaluation Unit* has issued every year a set of broad guidelines (some 30 pages documents). These were revised for each exercise in the light of experience gained and expert recommendations. Effort was made to ensure flexibility in the exercises, while ensuring coherent and timely input to the legislative process.

Finally, the *Evaluation Unit* organised international evaluation workshops where experts from Europe and beyond have participated.

[9] That means, the two Framework Programmes and their constituent Specific Programmes; cf. Durieux/Fayl 1997.

## 5.5 Input to Legislation

Two overall, five-year assessments exercises[10] have been conducted under the responsibility of the author. Their outcome provided essential inputs to the legislation of the Fifth and Sixth EU RTD Framework Programmes, respectively.

The political credibility of these exercises has been underlined by the fact that several former research ministers and other international personalities have participated in the expert panels. In addition, the validity of the panels' reports has been supported by a large number of: submissions to the exercises from national governments, European bodies and institutions; interviews with members of Programme Committees, Commission's director-generals and directors; overviews and additional data and analysis provided by the *Evaluation Unit*, etc.

With the new scheme, the Commission services have moved in the right direction. The political pressures have to some extent lessened regarding the quality and usefulness of evaluation. Among others, the CREST Evaluation Sub-Committee stated:

- The "monitoring process has developed into an integral part of the Framework Programme and that it has proven useful in a number of ways when developing the overall implementation of Community RTD activities".[11]
- The "five-year assessment reports have provided useful contribution to discussions on the Fifth Framework Programme […]/CREST/ generally welcomed the reports recommendations as useful suggestions for improvement of on-going work and as a relevant point of reference in preparation of FP5".[12]

The Commission's own internal audit has on several occasions described the evaluation system as "well-established and mature".[13]

The 1999 Framework Programme Monitoring Panel concluded: This "year's external monitoring has been carried out in parallel with an external five-year assessment for the Framework Programme as well as each Specific Programmes. The overall effort, one of the most comprehensive programme evaluation carried out anywhere involving some 140 experts working simultaneously in 18 panels, is a major achievement in itself".[14]

Clearly, exchange of knowledge and experience within the Commission services and working together with best European evaluation experts enabled the Evaluation Unit to develop a workable and credible research evaluation scheme at the EU level.

In spite of all the above, it would be far fetching to claim that the evaluation exercises have enhanced the Member States' willingness to open their money-box and more readily provide funds to EU research. Such fund allocation at EU level is always a complex and lengthy, and some times an agonizing exercise.

It is quite probable, however, that had the evaluation reports not been up-to-standard and not met the Member States' expectations, the budget approval process would have been considerably trickier.

## 5.6 New Challenges

The expectations of – and consequently the pressure exerted on – public policies have continued to increase. Scarce public funds (not unrelated to the overall macro-economic situation in the Member States) have added to this pressure. Research policy has not been exempt from these trends. On the contrary, its relative inability to concretely demonstrate its usefulness and impact on key societal issues has led policy-makers to re-visit the issue.

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[10] Cf. "Five-year Assessment of the European Community RTD Framework Programmes", EUR 17644, 1997, and "Five-year Assessment of the European Union Research and Technological Development Programmes 1995-1999", EUR 19426, 2000.

[11] "Report to CREST on the 1997 Annual Monitoring Reports" (internal CREST document).

[12] "CREST Opinion on the 1996/97 Five-year Assessment" (internal CREST document).

[13] Cf., e.g., "Report of the Financial Controller on the Organisation and Systems for Evaluation". European Commission, SEC (1999) 61/5, February, 4, 1999.

[14] "1999 Monitoring: 1999 Annual Monitoring Report on the RTD Activities Conducted Under the EC and Euratom Framework Programmes". EUR 19374, 2002.

Due to various pressures, the need arose to take another look at the orientation of EU research themes and objectives. The following criteria emerged to the forefront:

- Those relating to social objectives, such as improving the employment situation.
- Those relating to economic development and scientific and technological prospects, which include areas that are expanding and create growth prospects.
- Those relating to "Community Added-value" and "subsidiarity" principle, such as the need to establish a "critical mass" in human and financial terms.

It became evident that to be able to cope with emerging challenges, the EU RTD effort needed to be supported by more effective and efficient monitoring and evaluation tools. These included quantitative and qualitative indicators capable of demonstrating impact. In particular, CREST exerted considerable pressure to move in this direction. The Commission services have adequately responded to this pressure and successfully introduced a set of core indicators (cf. Fayl et al. 1997).

The *Evaluation Unit* has made a concerted effort to encourage programme managers in the Commission to take initiatives relating to impact assessment. It has also organised closed brainstorming meetings and larger workshops with international experts, and supported targeted expert studies. Some of resulting reports have eventually become internationally recognised reference documents (cf., e.g., Georghiou et al. 1999).

Due to various pressures internal and external to the Commission, the evaluation scheme has further evolved. Quality standards have been introduced. These focused on ensuring quality of: methods, evaluation reports, communication of results, and organisation and feedback.

But, in spite of all these developments, the evaluation scheme remained complex and, due to its bureaucratic complexity, could not easily produce quick responses to unforeseen developments. The scheme could be fragile should the external political pressures increase. Potential conflict with decision-makers could not be excluded.

The internal and external pressures to reduce bureaucracy, without jeopardizing quality and credibility, have continually mounted.

## 5.7 The Way Forward

After some six years, being responsible for the research programme evaluation within the Commission services, the author moved to other duties within the Commission services.[15]

Before that, based on several years experience and in-depth discussions with some of Europe's best evaluation experts, the author together with members of the *Evaluation Unit* made a set of recommendations for further development of the evaluation scheme (cf. Fayl 2000). The suggestions aimed at reducing bureaucratic constraints and meeting future challenges, while respecting legislative obligations.

The key recommendations were:

- *Monitoring*: (1) a single expert panel (Framework Programme and Specific Programmes together) should conduct the entire exercise; (2) the panel should focus on a limited number of key issues relating to management and progress relative to annual targets; (3) the programme directorates' involvement in the monitoring process should be increased through self-assessment reports and impact assessment studies.
- *Five-year assessment*: (1) also here, a single panel should conduct the entire exercise; (2) more effort should be devoted to meet expert panels' requests for supporting studies, data, etc.
- *Programme directorates should* more readily promote positive evaluation culture within their services, thus avoiding evaluation being perceived as an onerous control mechanism.

The above recommendations have been for the most part considered. The currently used evaluation scheme has been developed in this direction.

[15] The author's following responsibilities included setting-up and initial co-ordination of the European Research Advisory Board (EURAB).

# 6 Lessons

Convincing arguments must support request for public research funds. Evaluation helps to provide such arguments. The author's experience has shown that it is achievable to design and implement a credible evaluation scheme in a highly complex research environment without undue conflictual situations with legislators. The scheme has helped to formulate constructive inputs to legislation and reform.

In order to be successful, minimum necessary pre-conditions must be met. These are:

- *Readiness* by colleagues and hierarchy within the organisation to co-operate across bureaucratic barriers (*the importance of this critical issue is often underestimated, if not overlooked*).
- *Availability* of reliable data as well as expert advise regarding state-of-the-art evaluation methodologies.
- *Indulgence* by legislators to accept trial-by-error approaches.

## 6.1 Useful Conflict

Legislation may or may not expressly stipulate research evaluation as such. As evaluation helps to provide the necessary trustworthiness of scientific advice needed for legislation, it should always be carried out as routine operation – in the opinion of the author.

However, evaluation of questionable quality could lead to conflictual situations and delay decision-making or, in the worst case, provide reasons for no-decision. The author's experience is that tensions, to a certain degree, can be helpful in any research system. It could help researchers to better face political realities, notably limited availability of public funds. On the other hand, politicians would be obliged to distance themselves from scientific ignorance and refrain from requesting un-realistic short-term results in return for public money. Mutual indulgent and respect between those often contrasting opinions could eventually develop.

At the same time, as evaluation is not a straight-forward simple route, better understanding by evaluation experts of inherent dynamics of public funds allocation process could have beneficial effect on the quality of evaluation outcome. In particular, experts would be more conscientious to apply up-to-date methodologies of highest professional standard.

## 6.2 Policy Design or Brake for Reform?

Evaluation is a complex process. It is much more than a straight-forward march from simple facts to well-thought conclusions. Evaluation is a combination of knowledge of- and personal experience with S&T related issues, understanding management and competitiveness principles, understanding of apprehending factors that influence the outcome of co-operative research, and much more.

Some experts claim *"evaluation is itself an art"*. As for the tone of a violin that not only depends on the instrument itself but the artist playing on it, the expert evaluator can influence the outcome of evaluation. In this sense, there is no simple and indisputable response to the basic question raised in this paper: "Is evaluation a tool for policy design or a brake for reform?" It could be both, depending on a plethora of factors and circumstances. Including the evaluators themselves and the users of their results. Trustworthy evaluations schemes must be carefully tailored and optimised to individual circumstances.

As regards the evaluation scheme developed by the *Evaluation Unit*, one can only make guesses about its impact on EU research related legislation. It is quite probable that had the outcome of evaluation exercises not been up-to-standard and not met the decision-makers' expectations, the budget approval process would have been considerably trickier.

# 7 And the Future

At the time when science is in the centre of both major hopes, concerns and fears, evaluation of its impact on society and economy has more than ever become a critical issue. This is reinforced by the fact that the scientific community has to cope with a relative shortage of public funds. All this calls for more concrete evidence of S&T policies' usefulness. As the environment of European S&T policies becomes simultaneously more competitive, it is necessary to adapt and further develop the evaluation tools and schemes.

While all being different and rich in own history and culture, in Europe we recognise that we share common fundamental values. We should nurture this great asset also in connection with research evaluation. In order to address the challenges ahead, we must take advantage of this unique capital and progressively build a European evaluation culture that is based on our cultural- and historic commonalties, combines our strengths and minimises our weaknesses.

This implies, inter alias, further encouragement for constructive dialogue and information exchanges between experts. They should work side-by-side to find the best ways to measure our achievements. It will allow making best use of research results and taking appropriate corrective actions. The universal nature of science will certainly, in this respect, help us not to be succumbing to our differences.

Conflictual situations with decision-makers will always remain possible. Every effort must be made to produce evaluation of highest quality and professional integrity. Solely trying to please legislators and hierarchy, or fellow scientists, is treacherous against taxpayers and professionally immoral.

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## Annex A: Definitions Relating to Research Evaluation

*Monitoring* is a process by which information on the progress and direction of ongoing research is generated mainly for management purposes.

*Evaluation* is a process by which the quality, implementation, target relevance, and impact of research are examined and interpreted. Consistent evaluation exploits the outcome of monitoring.

*Self-evaluation* is an on-going process by which researchers monitor and assess activities under their responsibility. If the activity is a part of a research programme, self-evaluation is made against the programme objectives.

*Assessment* is a synthesis of facts that arise from the evaluation process and related judgements. According to this definition, assessment is a policy-tool for planning of new research. Consistent assessment exploits the outcome of all the above.

In spoken language, unless otherwise stated, the word "evaluation" often means all of the above.

*Audit* is a legal and/or technical review and examination of research management, finance or account of an organisation, a research programme or a particular activity. This process, when conducted methodically, facilitates enhanced efficiency and improves the quality and value of research.

Other definitions relating to research evaluation are:

*Efficacy*: assessing relevance, i.e., whether the initial objectives are still valid in the light of evolving circumstances. If this is not the case, an attempt is made to identify relevant objectives. This effort should help to increase the likelihood that the research in question should produce useful and valid results as well as help to identify important spin-offs. Expert guidance and input from technology watch are useful guiding tools.

*Efficiency:* assessing effort, i.e., issues that have a direct bearing on success to achieve objectives in a cost-effective manner. This includes: adequacy of funds; management performance (e.g. identifying research themes, awarding funds, monitoring progress of funded research and terminating them, if warranted, etc.); contract obligations (e.g. implementing procedures, employing funds, etc.); and producing and disseminating useful and valid results.

*Effectiveness*: assessing impact according to objectives, i.e., benefits for the scientific community (e.g. mobility of researchers, networking, number and quality of publication, etc.) and society as a whole (e.g. patents, improved / new processes / products, multiple-use technology creation, etc.). Ideally, effectiveness should address employment issues.

*European Value-Added*: outcome with broad European relevance resulted from joint efforts between several countries; a single country can't effectively achieve it.

## Annex B: Conflict between Politics and Scientific Advice

(The following presents an example of such a conflict:

Excerpt from: Fayl, Gilbert; Fayl von Hentaller, Ulric: Put Our Money where Your Mouth is – Engage Talented Youth. In: NATO Security through Science Series, E: Human and Societal Dynamics, Vol. 16: Science Education: Models and Networking of Student Research Training under 21. Amsterdam 2007. At their Brussels meeting on December 15-16, 2005, the European Council disregarded the multi-annual budget proposal put forward by the European Commission. The proposal was based on global socio-economic reasoning and considered a whole series of scientific advice. The latter have taken into account evaluation of current and previous EU research activities as well as assessment of need for continued European research.

Political forces overrode plausible advice.

The Council agreed to a budget for 2007-13 that critically falls short of matching their previous pledges. Due to short-sighted national interests the much-needed drive to revitalise EU economy remains overdue. The most alarming seems to be that political leaders are reluctant to grasp the gravity of the state of affairs.

It was only a few years ago (in Lisbon in 2000) that these leaders adopted an ambitious ten-year programme to revitalise growth and sustainable development across the EU. Against the background of sluggish economic growth, in this initiative – known as the "Lisbon Strategy" – the EU "set itself a new strategic goal for the next decade: to become the most competitive and dynamic knowledge-based economy in the world".

In 2002, the Barcelona Target became an essential part of the Lisbon Strategy. Based upon the recommendation of an expert group, EU leaders agreed "that overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010".

The EU is lagging behind its global competitors. The competitive gap is widening or in best case close to stable. The "European Innovation Scoreboard 2005" (European Commission, January 12, 2006) paints a grim picture for the EU innovation performance as a whole.

Both the Lisbon Strategy and Barcelona Target demonstrate political determination at the highest level and political leaders' credibility is measured against their own pledges.

The 3% figure is not magic. The issue is far more complex. There is no straightforward relationship between R&D spending and primary measures of economic success. But spending too little will definitely harm. However, simply spending more does not necessarily enhance economic performance and competitiveness. In this sense the 3% is a plausible objective.

Yet, at their December 2005 meeting, despite all the above, EU leaders allocated funding for R&D and innovation that is a far cry from their own highly publicised ambition. This under-funding is inexcusable. The obvious lack of political wisdom and courage are signs of the sad state of affairs in the EU's "top political machinery". Single-minded national interests come to the surface and overshadow "the greater good".

However, giving credit where it is due, EU leaders are only partly responsible for this unfortunate situation. In the absence of a clear road map to re-engage citizens, leaders continue to pay homage to a double-faced deity: publicly championing the EU case and behind closed doors defending narrow national interests.

In this climate, they leverage the EU for domestic policy and make it the scapegoat for all the unresolved problems relating to domestic affairs. Today, more than halfway through the Lisbon timetable, the progress and results so far are disappointing. The EU will find it exceedingly difficult to meet its initial Lisbon targets for and by 2010.

Could the Lisbon Strategy have been illusory from its very inception? Could a block of 15 states (EU members at the time when the Strategy was agreed) within 10 years transform itself to "the most competitive and dynamic knowledge-based economy in the world", while at the same time taking on board another 10 states?

One might want to consider that eight of these new member states and their economies had suffered for more that 40 years under the yoke of the former Soviet Union.

Whatever the answer may be, the Lisbon Strategy has started a process that can only be beneficial for the entire EU and possibly beyond. By now, the process has become more important than the initial objectives. This must be acknowledged. But in a few years time our political leaders – those still in office – will be held responsible for not making good on their own initial promises.

Consequently, the first reaction of the European Parliament must be saluted. It overwhelmingly rejected the agreement reached by heads of states and governments that “does not guarantee an EU budget enhancing prosperity, competitiveness, solidarity, cohesion and security in future” (January 18, 2006). Such a firm stance in the interest of Europe will most certainly enhance the Parliament’s political credibility and relevance, and strengthen it as an institution serving the interest of European taxpayers.

On the broader question of how to revitalise the EU economy, responsible political leaders in Europe must once and for all realize that highflying declarations are insufficient. Research is the most important source of innovation (the Scandinavian countries are outstanding examples). It drives economic growth, job creation, structural renewal and social cohesion. EU leaders must champion R&D and innovation both at the EU-level and at home.

Without acting in this spirit, Janus faced policies will make a European fata morgana out of the Lisbon Strategy and the competitive gap between the EU and its major global competitors will remain or continue to widen.

The much-needed drive to revitalise EU economy remains overdue.

# Toward "Innovation of Innovation" by "Taking European Knowledge Society Seriously"

*Ágnes Fésüs, Imre Hronszky*

## 1 Introductory Remarks

This article is a series of remarks on a very important report made by an expert working group for the European Commission in 2006. The Science, Economy and Society Directorate of the DG RTD at the European Commission mandated that group in 2005 to prepare an assessment of some perceived problems with European science and governance. They were also trusted to give suggestions how to solve these alleged problems.[1] The group was charged first of all to answer the problem of how to manage the – alleged – growing general public unease with science. This alleged unease was identified as a main obstacle to economic competitivity of Europe in the global arena. But the group was also simultaneously asked to give suggestion how to raise involvement of the civil public in democratising innovation. As we shall see the answer the group gives is based on a profound reconstruction of the whole problematic of the alleged general "public unease". They realised a diametrically different problem and suggested a diametrically different solution to it. Their reflection of the situation demonstrates that there is a selected unease concerning some special science-based technologies but it is surrounded by enthusiasm for others. The report also investigates this real unease reflexively and evaluates it as an essential and very rich resource for a rather different innovation dynamic.

The task to solve the original questions was put into and reflected on by the critical STS (Science and Technology Studies) perspective of the group. To make understood and to justify the transformation of the questions and the answers given on the transformed questions required them first to outline this perspective. This way the report not only gives an alternative answer to the problem of the alleged "public unease" but also makes some sort of concentrated presentation relative to a different model of innovation dynamics.

The group gave the provocative title of Taking European Knowledge Society Seriously (TEKSS) to the report. An "innovation of innovation" is needed, they proclaimed, that would be realised by providing for a different overall frame for innovation efforts, a different relation of innovation to economy, society and politics.

It is worthwhile to provide focus to all this at the beginning of this article. In nutshell, the starting point of their argumentation is breaking with the still dominating assessment of (partly only alleged) public unease by most industrial and political agents, scientists, technical experts, and the "therapy" suggested for it. That dominating evaluation, based on some one-sided perspective on some empirical evidence, identifies concerned attitudes (of consumers, patients, environmental groups, etc.) as nothing but an obstacle to the accelerating growth of an innovation based economy. If you accept that assessment then the resulting management suggestion is clear and justified. According to that suggestion, if you want to rise competitivity it is essential to abolish these obstacles. Education is a main instrument to abolish the (possible) roadblock because the source of resistance is allegedly identified in the basic lack of knowledge by the public of what science and science based technology and its role in the global competition race is. Presuming that the public is able to think rationally it is then expected that the public attitude would change through some sort of enlightenment, education, or "learning the truth" about science and science-based technology.

Continuing the several decades' long tradition of critical STS a determined turn with the assessment and evaluation of the role of concerned groups in innovation was suggested by the expert group. On this view, concerned public(s) (may) correctly identify basic societal problems with new science and technologies. That is their main perspective. This determined turn in evaluation of the situation leads to a different policy suggestion. On this suggestion, instead of trying to abolish concerns, it is to fully integrate the critical, con-

[1] The group the Directorate trusted in 2005, beside some NGO and labour organization representatives, mostly consisted of leading STS scientists such as Michel Callon, Sheila Jasanoff, Andy Stirling, Arie Rip, Ulrike Felt, and the head of the group, Brian Wynne. In this respect the report can be seen as a representative collective assessment of alleged problems with the science and innovation dynamic from a social critical STS point of view. It was published as Felt/Wynne 2007, further referred to as TEKSS.

cerned consumer, citizen, etc., attitudes into the whole innovation process from its first step, the goal setting. The perspective and dynamic is perceived as nothing but a hindrance, a road blocking effort, turns to be a most essential driving force in a different perspective and dynamic. This perspective and dynamic is based on different values, on different goals for science, technology and innovation policy and is based on critical co-operation among all the possible agents.

In this way, critical consumer and citizen attitudes turn into an essential resources for comparative economic advantage, a sustainable type of innovation in which the pace and acceleration of innovation are not the supreme objectives but the appropriate societal direction of innovations. The suggestion is that not simply supporting growth should be the primary goal for innovation dynamic, but the sustainability of the dynamic in the long run. Scientific and technological potentials that quickly emerge should be refocused on this goal.

Two different purposes unify the change of direction of innovation activities. They become two sides of the same dynamic. Not only should the direction of innovation be changed by this type of discursive participation but by turning the concerned groups into essential systemic agents of a changed type of innovation dynamic, some element of political democratization of society would also be realised. This should be the needed result of democratization in a type of society that in an accelerated way is mediated by science based technology by clusters of innovations of which the capability to foresee their effects is very limited. According to the critical claim, as we interpret it, in a rich discursive milieu, different autonomous publics, “bio-users”, “info-users”, “women bio-users”, etc., would simultaneously realise their instrumental and political relations to new technologies. They would not only “democratize” the development of innovation by engaging active users and shift power what the users will waste, to say it with Eric von Hippel (cf. Hippel 2005). This is a limited perspective. The democratization the TEKSS group aims at is more then that. It is about fully integrating the “bio-citizen”, “info-citizen”, etc., critical political relations in the innovation dynamic, as critical reflexive relation to technological development. With a form and dynamic different from the recently typical instrumental relations but also a new sense providing relations to technological innovation can be realised. That is the realisation of deliberative political democracy in governance of science, technology and innovation (STI). As we emphasize with this, some sort of special “social robustness” can be provided that overcomes the shortage of the progress identified by Hippel. This is realisable because it would essentially include, as valuable partners, adversary agents.

Actually the main message of the group seems both very profound and very simple. Let us put it in our terms. Every societal dynamic integrates the socio-political, the economic, the scientific and the technological dimension somehow. The recent dynamic integrates organised innovation efforts as serving first for market goals. The recent dynamic aims at enhancing consumerism first and may prove myopic this way in terms of societal needs. Goals of innovation may prove less appropriate or mediated in a too complicated and inefficient way for societal goals or/and negative “side-effects” of new innovations won’t be adequately met in this dynamic. The recent innovation dynamic should be criticised as alienation from the human essence in pure consumerism. This is less explicitly the perspective of the group. They concentrate on the participative democracy need in the governance of STI. This approach is more sociological.

The emerging recent global challenge identified by the group is about differently integrating the socio-political and the economic in a changing innovation regime. A turn should be realised by the profound integration of that negation that would realise a new type of innovation dynamic. That would lead to exploring socially robust and sustainable innovation possibilities and realisations of innovations in an ongoing process of discourse. This would make the innovation dynamic more sustainable and democratic. All this becomes especially important for an emerging technological revolution never before seen in earlier in history, at least not with this pace.

The view of the group is offered by the authors as the possible peculiar European innovation model to challenge the recent myopic, reductionist, instrumentalistically biased global innovation race that moves in the circle of raising consumption and consumption friendly customers ready to realise the uncritically raising consumption. It is offered as the model that would reward Europe in the global race for comparative advantage, for the turn becomes necessary and much pioneering work has already been made in the road of inclusion of the critical public. Europe could take the leading position when the mainstream in the global competition would turn from solely concentrating on the “speed imperative” on what may be called the “direction imperative” set by concerned groups for the innovation dynamic.

The report differentiates topics that are identified essential to search through an ordered way. “Reinventing innovation” is the overall perspective. This needs the turn from the recent regime, as they call, at the Regime of Economics of Technoscientific Promises to the Regime of Collective Experimentation. To clear their requirement of the transition to the Regime of Collective Experimentation the report first assesses how Europe was recently tried to be normalised through (risk) science and takes into account the problems of risk, uncertainty and precaution. It turns then to the new normative discourses in European science and governance, how ethics is about stepping into the place of law in regulation and criticises two sorts of developments. They are the tendency to scientification of ethics and bureaucratisation of the integration of ethics into the innovation dynamic. This happens through solely integrating ethical advisory groups into the bureaucratic mechanism of regulation. With this the danger of simply setting new regulation fixes for strengthening the bureaucratic regulation is identified by the group. Formation, performances and encounters of European publics follow this topic in the report. The changing ideas about learning by the public from the enlightening education by technological experts to learning through engagement are the focused topic here, in dealing with the formation of publics that goes to sketching ways of collective knowing. The next chapter in the report investigates into what learning is and the last one before formulating conclusions and recommendations describes and analyses what imaginaries and narratives are. It reflects on the relations of what they term “master narratives”, the most comprehensive narratives on European science and governance.

## 2 Unacceptable Public Unease meanwhile a Need for Democratization of STI Dynamic?

The expert group received the mandate from the Commission to respond to the questions below with the task of concentrating on the first question:

1. “How to respond to the widely-recognised problem of European public unease with science, especially in relation to new science-based technologies?”
2. “How to further the stated EU commitment to improve the involvement of diverse elements of democratic civil society in European science and governance?”
3. “How at the same time to address urgent European policy challenges that are often taken as strongly scientific in nature – including climate change, sustainability, environment and development?” (Felt/Wynne 2007, p. 9)

As mentioned already the group committed a self-undertaken extension of the task. This not only gives the group evidence in the report that the first question is over-generalising and misleading but connecting the first question to the second visibly demonstrates how fractioned is the overall policy approach to science and technology by the European Commission. On the one side, this policy deals with the problem of supporting the global competition race perceived only in terms of acceleration and efficiency. But it deals on the other side with political democratization of the European science and governance dynamic. But to solve both problems simultaneously by simply unifying both efforts, that means supporting an innovation model that is inclined to identify concerned as a negative value and giving way to political democratization of innovation simultaneously that identifies concerned as a positive value is trying to produce an oxymoron. Instead of accepting the task to support developing an oxymoron, the group, by expressing a critical STS view, shows that concerned publics who are nothing but potential roadblocks in one perspective and subjects of enlightenment are most valuable resources in an essentially different model for the innovation competition by politically democratizing that dynamic with their integration as concerned actors.

Putting the third question into focus too, in comparison to the two others, may be down valued by some readers claiming that that question is really mostly a scientific-technological question. But that would be a profound misunderstanding. Inclination to identify questions of climate change and sustainability as “mostly scientific-technological” questions is unacceptable because their overall framing dimension is genuinely societal-practical and political and is in need of its ongoing reflexive discussion by the publics.

The received dynamic is still dominant but there are deep challenges emerging by now, the report states. These challenges come from different corners. One challenge is that the complexity of the societal-economic dynamic is already everywhere and is rapidly rising. Another challenge is, at first glance just wishful thinking, the quickly raising need for what we can call the democratization of the field of the epistemic. Taking into account the recently developing needs for a more participatory democracy and the already existing capabilities to realise it, first of all that rigid and hierarchical division of labour proves un-sustainable, that science and experts simply tell the truth that sets the factual knowledge boundary for action. Real science proves to be full of decisions due to unavoidable basic contingencies in framing both the research problems, methods of exploration and evaluation of the results. "Democratizing science" means to open these decisions, uncover the contingencies and repeatedly re-discuss them when there is suspicion that the chosen ways will have possible unacceptable political consequences, in terms of inequality, environmental sustainability, etc. The reason for tending toward a participatory discourse type of deciding on the chosen framework(s) for policy otherwise found relevant knowledge is to find less decisionistic, less arbitrary framings than recently.

Are concerned groups and in special cases the everyday citizens able to realise such a role in framing scientific-technological discussions? Should the public know the same sort of knowledge experts have? This is obviously impossible to realise because it is a self-contradictory requirement, but it is not necessary either. Sheila Jasanoff elegantly describes what the general public is interested in the assessment in issues of science and technology and what it is able to discuss (cf. Jasanoff 2005). Concerned groups engage in critical discourse of frame setting for sciences and technologies, based on their problematic experiences with innovations, problematic in some terms of their basic values.

It is most important to call attention to a most recent stylised fact in the global innovation arena. While it is still profoundly disbelieved by the majority of scientists or policy makers that participatory processes provide for the most important critical knowledge, to make it both more democratic and richer in content, on the other side, parallel and in contradiction to these types of impossibility theses, "the economy", "the industry" has just begun to quickly learn to tap in and set great value on the recently recognised cognitive participatory resources that may prove most valuable for realising different sorts of "open innovation". There is already a rapidly growing global experimentation with most different types of "participatory open innovation". This includes re-discovering capabilities of different sorts of everyday and specialised users, especially on the level of designing products, etc. So, the learning is that concerned citizen or occupational groups, special groups of affected people like patients in medical issues (not to speak about scientists and engineers who themselves may have problems with possibilities of special negative externalia) are cognitively able to be partners with appropriate knowledge in framing discourses. The result of a cooperative framing would be a wider and different knowledge base and a socially more robust innovation dynamic than that only based on expert knowledge.

## 3 Changing Place of Science and Technology in Society

There are some basic tenets of critical STS that are essential to keep in mind to be able to follow the way the report realises. The first is that any technological innovation is a socio-technological innovation, a co-creation of technology and society. This is the easiest to see with radical or breakthrough technological innovations. Any such technological innovation unavoidably has a wide range of co-produced requirements and impacts, economic, legal, social, cultural, on everyday life, ideological, etc. Some of them are of radical change, of breakthrough nature. The question is how these effects are produced, what sort of influence the customers, citizens, workers, women, etc., have on forming the impacts of which some in some forms they unavoidably have to face. Let us briefly see how the report answers this question.

Let us go back to the first question the group got to answer, the alleged growing general public unease. The first step made by the group was an essential reexamination of this alleged concern. It was the factual checking if this general unease existed at all. Is there, in the EU, really some general public unease with science (and science based technology), some sort of growing rejection of science as a whole in solving societal problems? The answer is a definite "no". Instead of a general disaffection they identify that "there is selective disaffection in particular fields of science, amidst wider areas of acceptance – even enthusiasm" (Felt/Wynne 2007, p. 7). The difference of general and selected is essentially different from simple gradation. It shows that the public is not simply dogmatic when it assesses science and science based technology but it makes choices. Two questions emerge then. What sorts of sciences and technologies awake public unease and on what base and what sorts of mechanisms provide for some sort of over-generalisation of the really existing disaffection from what sort of perspective?

The report embeds these problems into the wider perspective. There are wider basic societal and economic, political changes as well as with science such as that the EU moves "from a single economic market to a more political union", that brings with itself "changing expectations concerning science and governance". Meanwhile, science moves from a partly only alleged "Independent Republic" to "science as servant of innovation". "Science is increasingly commercialised in particular areas affecting public trust and the ways in which science and expert judgment feed into governance are shifting and become ambiguous" (Felt/Wynne 2007, p. 10). But science and technology are tacitly shaped and framed by deeper social values and interests and these framings as they are now realised are widely coming into question by the public by now with the changing dynamic – they state. This means that the embedding of science in society, at special issues became problematic, for different citizen groups.

Safety of new technologies was only identified by innovators and policy makers as problematic for the public earlier not the goals of innovations themselves. Safety research was realised as quantitative risk assessment (qRA), as risk science that served for bureaucratic risk governance. There are different problems with this approach. First, from the whole innovation process that is an upside process of setting and realising the goal of the innovation and a down-side process that includes investigating into the adverse environmental, health, etc., consequences, this mode of institutionalisation, the still dominant approach deals only with the inclusion of the public in the down-side regulation. That only deals with the adverse consequences of innovation efforts.[2] Second, this is done by further reducing the interest in the full range of "uncertainties" into quantitative risk assessment, even when assessment of uncertainties beyond calculable risk proves to be essential. The report realises what can be called a manifesto of the critical social and technology studies: all this should be integrated into a different sort of embedding science and technology in society. This has two sides. As the authors argue it is time to turn from down-side "risk-governance", from the approach that only concentrates on the adverse affects of some innovation, to "innovation-governance". That "innovation-governance" is first of all upside governance integrating the agency of concerned publics in partaking in decisions over the goals too but also in dealing with the possible adverse effects in their full width, giving way to understanding all the different types of "uncertainty".

All this challenges to change the present narrow understanding and practice of innovation with a "more socially distributed, autonomous and diverse collective forms of enterprise" (Felt/Wynne 2007, p. 10). This includes essentially utilising the diverse civic "knowledge-abilities". "This promotion of diverse civic 'knowledge-abilities' would perhaps be the most effective single commitment in helping address legitimate public concerns about Europe as a democratic knowledge-society, able to hold its own distinctive place in a properly-grounded global knowledge-economy" (Felt/Wynne 2007, p. 10). This is what the authors suggest as "innovation of innovation". This is inclusion of critical citizens into the whole dynamic of innovation as discursive partners. Because they have some special civic knowledge-ability their systematic inclusion both democratizes innovations and adds a basic resource to innovation. In this way this inclusion helps to make innovations socially robust and sustainable.

# 4 The Public as Possible Roadblock to Innovation: "Folk Theories" of "Enactors"

As mentioned already, the report itself does not devote long argumentation on how the type of attitude works that results in the alleged thesis of general concerned by the public. A member of the group, Arie Rip utilised and further developed the view of "folk theory" some years ago that provides for more detailed interpretation.[3] We summarise this and add some remarks to it. As Rip explains, our actions are surrounded

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2 Actually, this is realised even in a more restricting mode. This restricting mode is including the public only into the management phase as partners, not into the assessment of quantitative risk. Risk assessment is recently dominantly made by risk experts alone.

3 We rely on the terminology introduced by Rip. To understand what a "folk theory" is we follow his article (cf. Rip 2006). Raghu Garud and David Ahlstrom draw attention to the asymmetry in the debates around emerging innovations (cf. Garud/Ahlstrom 1997). Their assessment is based on contrasting "insiders" and "outsiders". As for the differentiation of "insider" and "outsider" Rip summarises the issue as follows: "there are different socio-cognitive perspectives linked to two basic positions. Insiders who try to realize, 'enact' a new technology, construct scenarios of progress to be made, and identify obstacles that must be overcome. They think in progress and obstacles to it. Thus, they work in 'enactment cycles' (Garud and Ahlstrom 1997, p. 410). Such 'enactment cycles' emphasize the positive aspects of the new option, and work through an illusion of control. Outsiders who are faced with this option, but see also other options (up to the null option of not going for any innovation), pursue 'selection cycles' in which they can compare the option with alternatives (Garud and Ahlstrom 1997, p. 410)" (Rip 2006, p. 361). Rip shows that "Garud and Ahlstrom's terminology of 'insiders' and 'outsiders' can be improved upon. This way of characterizing actors pressumes a boundary between an inside and an outside. In fact, the key point of their own analysis is the difference in socio-cognitive position and style of activities. So one had better speak of 'enactors'

and interpreted by different "folk theories". Around actions there are "insiders", "enactors" who are committed to realise the action and "outsiders", "comparative selectors" who critically follow what is done, in respect to their interests and different other relations. Typical for "folk theories" of "enactors" is the one sided, selective taking into account what is relevant for them and what is the value of what is relevant. Rip uses the "concentric thinking" metaphor in this respect. "Concentric thinking" means a special type of myopia. On this view actors first present their problem from a management perspective, in terms of their goals and the barriers hindering them to achieve in a series of "enactment cycles", only gradually broadening their perspective when they get constrained to do so.

"Enactors" are those agents who commit to realise something. They are mostly inclined to be uncritically committed to the innovation process in question. They align around it, and their "hard core" at least commits itself. They may be scientists, engineers, firms depending on the innovation in question, funding agencies, governments, venture capitalists, etc., based on their socio-cognitive position, socio-structural place, education etc. "Enactors" express their commitment with their goals and methods to realise them and identify any criticism as a barrier, as a roadblock to reach the goals. They set up and follow their "folk theory" about the issue to interpret the dynamic. In this way, their position, their attitude and their "folk theory" mutually reinforce each other.

Let us speak in a bit more detail of what a "folk theory" is. To express this in a most concise way we can say that it is knowledge of which not the content and its quality but its functioning for some practice is the most important. "Folk theories" are embedded knowledge. It is the basic epistemic characteristic of "folk theories" that their "facts" are not checked, at least not systematically. "Folk theories" may cover and explain everything, giving this way a full explanation to the issues, by some clustering of them. "Folk theories" are exempted from critical self-reflection. "Folk theories" express the perceived practical positioning and have a reinforcing effect on it. They may evolve in ongoing practice in details but evolve functionally. That means that they focus on serving the purposes of one group by providing for a more or less articulated explanation of the overall dynamic. Within this explanation they identify and explain a divide in the structure of the dynamic and the behaviour of those being on the other side of the divide. "Folk theories" actually are tangible expressions of an ideology, and help to decide on problematic issues in interest of some agents. This way they have a strong intention to realise some performing effect. They are holistic, provide explanation of the past, help choosing a possible future. They help make expectations that provide orientation and reinforce them. They are more or less explicit, but not very much articulated. They contain low level second-order reflectivity and so mostly formulate a dogmatic self-reflection. They are robust, embedded in action and prevented from readiness to identify self-made mistakes. All this means that it is difficult to change them, because they easily lead to short-circuit as self-defence. They are more or less based on experiences that are easily over-generalised and lack systematic checking. (We can say that one finds anespecially readiness to commit systematic falsification trials that would make them open for cognitive criticism, but is missing with them.)

We can better understand the functioning of "folk theories" if we recognise that the content of "folk theories" is less important than their functioning. First of all, they are not valid knowledge of the world they describe but function as ideology in some social context to which the cognitive functioning is subsumed. This explains why understanding of "folk theories" needs sociological explanation.[4]

"Enactors" mostly utilise a whole cluster of different partial "folk theories". A first type of "folk theory" in recent innovation issues is the explanatory and legitimating speech of what the global innovation race is. According to this there is a basic structural characteristic of the innovation dynamic that is immensely reinforced by globalisation. This is the self-accelerating unified global innovation race in which there will only be one winner ("winners take all").

With this we can identify a very typical characteristic of "folk theories". This is a "naturalization" of actors' activity in such a complex dynamic, such as the global economic race, in which a complex interaction of actions and frozen actions as structures exist. The conclusion for innovators is given with this "naturali-

and 'comparative selectors' instead. The more suggestive terminology of 'insiders' and 'outsiders' can only be used if there are good reasons to distinguish between an inside and an outside" (Rip 2006, p. 362). Taken into account that naming is a level of partaking with some commitment in a discourse to some ontology, we share the assessment given by Rip and use the terminology of "enactors" and "comparative selectors".

4 One of the "folk theories" that is still accepted by the majority of actors in innovation studies is the linear model of innovation dynamic. Benoit Godin gives a nice report on its origin (cf. Godin 2005).

zation": Any actor, in his/her best interest, has to try to behave according to this dynamic because this mechanism does not allow any alternative. From the point of view of ethics, "naturalization" has a liberating effect: the believer in the "naturalization" does not do anything else than she/he follows what is necessary, she/he makes choices only within the "naturalized" horizon. With this she/he reinforces the participation in a trial to make the dynamic she/he takes part in into a self-fulfilling prophecy.

The TEKSS report is to see as a radical assessment and management suggestion that is based on reflection on the basic framing of the so called Aho report (cf. Aho et al. 2006) or any economic theory of growth in which society is conceptualised as revolving around economy, and the economy is nothing but a global race with a well described linear logic, with the logic of growth with ever growing efficiency. Taken into account society, not the economic sphere, as the real centre but accepting some sort of challenge by the global economic competition, the TEKSS report concludes on the vision that to change direction of the global race is most important. The explanatory model includes argumentation on the emergence and development of those agents, the different concerned societal groups that start to influence change of the direction of innovation. TEKKS assumes that Europe may reach comparative advantage (actually it has some, for example in the field of clean energy innovations) by this modulation of the evolutionary process. The way to realise this modulation is a determined turn to integrate Europe's rich tradition of a critical approach to innovation into the innovation dynamic. In this way the TEKSS report formulates an incomparably more important conclusion than an answer that was expected by the DG Research to the alleged general concern of the public concerning science. To this conclusion belongs a determined change in innovation policy which should promote the emerging new innovation dynamic.

Let us continue discussing what TEKSS aims at, by further utilising the "folk theory" picture. The second type of "folk theory" of "enactors" provides for a perspective on history, with the main goal to reach a conclusion for understanding the future. This reconstruction of history states what sort of goals were earlier set in economic growth and what sorts of barriers emerged in similar situations of innovation dynamic earlier, such as with the agro-food GMO debate. We mentioned that typical for a "folk-theory" is how it reaches allegedly "valid" knowledge of the future. Due to the lack of higher order reflexivity the result of a historical overview is a simplistic extrapolation. Learning from the earlier agro-food GMO debate, from the perspective that one thinks in rigid structures, that other future important agrarian innovations may be stopped for a while too, through the resistance of special actors, mostly citizens, who do not understand their own interests.[5] The question raises then, how is it possible to prevent and overcome this barrier. As the TEKSS report demonstrates "concentric thinking" applies here with a special understanding of the task of what and how to learn from the past.

"Enactors" may remain first unlearned about the issues outside their perspective and do not find it important to learn either. When they understand that they have to react to criticism they identify it as nothing but resistance to their approach. Looking for the source of resistance "enactors" may find that critical actors do not share the goals of innovation, either or in a simpler case, that these critical actors at least have a fear of (perhaps still unknown) possible or already realised adverse effects. Beside the possible counter-interests this seems for the "enactors" to be mainly caused by the lack of adequate factual expert knowledge of concern people, at the "comparative selectors". Insisting on the goal(s) for innovation set by them only, and trusting first in enlightenment, enactors identify the way to overcome this resistance by the steady effort of realising public enlightenment.[6]

The process has a peculiar dynamic. A sort of exaggerated unease will probably cumulate with "enactors", if, notwithstanding repeated efforts, the suggested therapy, that seems to be the only rational way, does not work. The typical reaction by "enactors" is developing a "phobia of the phobia" alleged on the other side.

5 It is important to see that in this "folk theory" the future interests of the others are interpreted as "objectively" set and just to follow. So, the unified "folk theory" assures you that (1) there is a dynamic, (2) you have to follow the naturalized dynamic, (3) there are tools to realize this task, (4) the innovation is the interest of those too who will "consume" it, consumers, patients, women, etc. In the light of this representation much concern, resistance is at least doubtful and may be just irrational.

6 From the early 80s, following an earlier period of enthusiasm for science and technology the icon of which was the Atomium in Brussels, scientists and politicians, having had recognized some concerns concerning emerging new technologies felt a need to enlighten the public so that the public will be able to make a "correct appraisal" of the coming benefits of the technological revolution, mostly in informatics. Lack of factual scientific knowledge was identified as the main barrier and a movement from above, public understanding of science (PUS) started to overcome this barrier.

(Rip, engaged in research on an emerging technology, nanotech, gives the name of "nanophobia-phobia" to this symptom, at the emerging nano-debate: enactors do not want even to hear about the, alleged, nanophobia. – cf. Rip 2006). With this the process gets a temporary dead-end: the front is solidified.

In interest of looking for some solution different from this it is first important to recognise that "folk theories" falsely identify structural characteristics as invariants in any dynamic because they are able to dynamically change – in interaction with a radically changing dynamic. This radical turn would be the turn from enlightenment approaches to a discursive setting. In this oppositions can change into mutual partial acknowledgements as starting points and changes occur in the dynamic thereof. This would be a change in the whole frame of the dynamic, including the critical frame-reflective relation to the concerned groups and citizens and themselves as "enactors" too. But this means to open everything in the dynamic to mutual criticism, in interest of overcoming the frozen state to a critical co-operation approach that amounts to public engagement in the full dynamic. Unexpected favourable situations that open up possibilities of developing some "niche" can help to start changing the direction.

## 5 Risk Assessment and Its Fallacies

Let us turn back to the problem of downside assessment, the problem of uncertainty and dangers with new technological developments. We have to go back to the late 60s to trace what happened with efforts to assess, regulate and manage environmental and technological risks. Concluding from the debates in the 60s, first the government of the USA committed itself to make systematic regulatory and policy intervention of issues of risks. This led to the foundation of the OTA (the parliamentary Office for Technology Assessment) in 1972 that was dissolved in 1994. It also led to federal institutionalisation of environmental impact assessment (Environmental Protection Agency, EPA) also in 1972. The need for regulatory intervention by the state was identified as a need for extension of bureaucratic regulation and a risk science was required to identify the facts about non-intended bad side-effects to allow regulators to realise their work as science-based regulation. The famous article of Chauncey Starr of 1969 is especially important and iconic in the foundational work for the science of environmental risk (cf. Starr 1969). As Starr presumes "risk facts" exist outside. They can be "objectively" identified and measured and they have to be balanced with the calculated benefits, also some sort of objective things. Their calculation made by experts provides for the factual basis for appropriate management of risk.[7] It is to see that epistemological realism was the base of developing a risk science. It is still baserd for conceptions that try to give a unified basis for risk policy that intends "to balance" objective risks and subjective risk feelings and beliefs in a successful risk policy looking for appropriate compromises.

Risk was first identified by governments as exclusive object of scientific assessment. Risk science developed in two main directions. First it tried to extend quantitative approaches also to situations when it was not clear which events to take into account or when it was impossible to exactly take into account the probabilities. The recently dominating policy approach still rigidly identifies public concern about safety, as it is defined by regulatory science and expertise, as something full of misperceptions of the hard data of quantitative risk assessment (qRA) by lay people. QRA is one of the hot fields in the political debates with the public in technology political issues. Enlightenment of the public, to let them learn about the "real risks" to which risk science has the exclusive access, is a central accompanying effort by governments in rationalising behaviour in front of uncertainty.[8] In the risk science ideology, on the one side, qRA is able to uncover what "objective risk" is, while non-experts are prisoners of their senses and feelings. Allegedly, non-experts are often uncritical about their senses and feelings and may develop irrational fears. Indeed, they several times amplify, by even several orders of magnitude, what the provable real risk is or have fear from

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7 But at least one basic question Starr puts in 1969 is actually a question about normativity and this is a task of normative studies with a genuinely political part. This is the "How safe is safe enough?", in its recent formulation "What is acceptable risk". When only scientists answer it, in lack of their expertise in normative issues, their argumentation is committing naturalistic fallacy, a non-acceptable methodological mistake. Beside the need for participatory assessment of the framing issues even the reduced model exclusively based on expertise needs integration of expertise of values.

8 This is the place where we have to make the important remark that there are different sorts of concernedness, and rather often in the real practice concerned behaviours in the public concentrate around scientific misunderstandings. In this case enlightenment has an unavoidable role, even when the causes that lead to committing the fallacy are much more complicated. Think as an example how drivers typically overestimate their reaction capability, even when psychology proves their incapacity.

very improbable dangers. But this is not the whole story in comparing the risk expert and the citizen approach. The second direction to develop risk management was to develop the science of risk perception, to learn its regularities to be able to manage it.

In contrast to the narrowed down risk science interpretation of uncertainty, the TEKSS report, following the critical STS tradition, concentrates first of all on the framing issue. It puts the finger on the unavoidable contingent presumptions that frame any expert approach, meanwhile having some political impact. Critical STS concentrates on the issue how scientific and technological knowledge is constructed, what are the basic decisions made[9] and how the construction process effects political relations. It is to demonstrate in this respect that scientific risk assessment is a normative issue, and that only within some normative frame set, fixed for working, it is able to lead to scientific facts (cf. Felt/Wynne 2007, pp. 33-36). QRA has some unavoidable normative elements starting with the most straightforward of technical questions. "What are the relevant forms of risk (human health, environmental burdens, ecological integrity, monetary values, social disruption and ethical offence)? How should we measure these (for instance, health can be measured alternatively as frequency or mode of death or injury, disease morbidity, or quality of life)? What degrees of aggregation or differentiation across varied populations is appropriate?" (Felt/Wynne 2007, p. 34).

As any cognitive task risk assessment also gets its definite shape through the foundational decisions over the contingencies in the framing of factual research that may differently embed risk assessment in the socio-political practice.[10] While most risk experts may only concentrate on how to make data repeatable and just take it as a fact that to make their work possible they are constrained to make some basic decisions where alternatives are given, the critical approach concentrates first on the possible relation of setting the frame of factual research to their possible impacts in terms of politics. While a realistic interpretation of risk assessment by the dominating ideology risk assessment simply provides for the objective knowledge needed for a rational policymaking,[11] risk assessment is identified by critical STS as the possibility of doing politics with the chosen way among the cognition alternatives, meanwhile producing the appearance of simple objectivity, whether unconsciously or consciously.[12]

Concluding a long critical tradition, the TEKSS report puts the essential emphasis on the framing and the critical reflection on it. The framing with its social consequences is the first problem, not the problem with the results of the calculations within the given type of framing (cf. Felt/Wynne 2007, Chapter 3) that is nearly unanimously comprehended by risk experts. "What do we define as being 'at risk'?", "From what is it at risk?" questions are contingent and ambiguous. If the essential need for answering first these questioned is justified, then no methodological rigour can be the last judge as naive realism presupposes, but a possibly non-constrained, democratic deliberation over the framing, over the normative value assumptions that set the unavoidable preconditions for expertise. In lack of this there can be suspicion awakened, that these preconditions are set for some political advantage or are set by chance or by indifference for the political consequences of the chosen method.

This way you get two different views of what "uncertainty" is. For a naive realist it is something behind and over the calculated, because there is always something incalculable in real situations, but for concerned groups it can include uncertainty, ambiguity, ignorance or indeterminacy, even in a usual interpenetration of each other (see Table 30).

9 One further question is: How may these decisions may have got "naturalized"?
10 For example fixing the measurement of some risk by frequency of death or using more complex parameters will lead to different policy decisions.
11 It is "objective" in the meaning that their reproducibility does not depend on the researcher.
12 This is what we called "naturalization" above.

**Table 30: Different Qualities of Uncertainty**

- **Risk**: Under which we know both the probabilities of possible harmful events, and their associated kinds and levels of damage. This is where the various techniques of risk assessment are most usefully applicable.
- **Uncertainty**: Where we know the types and scales of possible harms, but not their probabilities. This is the best established "strict" definition of the term "uncertainty", under which "risk assessment" is strictly not applicable.
- **Ambiguity**: Where the problem at hand is not one of the likelihood of different forms of harm, but where the measurement, characterisation, aggregation or meanings of the different issues are themselves unclear, disagreed among specialists or contested in wider society. For example: How exactly do we define "harm" or "risk"?
- **Ignorance**: Where we don't have complete knowledge over all the possible forms of harm themselves. Where we "don't know what we don't know" – facing the possibility of surprise. This renders problematic even the questions that we ask at the outset in risk assessment.
- **Indeterminacy**: Where the possibilities for different social "framings" depend "reflexively" on complex interactions and path dependencies in the co-evolution of social, technological and natural systems. In other words, not only do our commitments and choices depend on what we know, but what we know is conditioned by our preferred or expected commitments and choices.

Source: Felt/Wynne 2007, p. 36

While for a naive realist risk and non-calculable uncertainty (what can not be calculated now) are two different groups of things, for a concerned perspective they may occur in an intermingled way, actually they occur in this way. Use of precaution will have a different interpretation. For a naïve realist precaution has only a supplementing regulation role,[13] for a concerned group standing on constructivist perspective it is an approach to possibly reduce the contingent and ambiguous nature of setting the risk discourse, reaching facts and managing the whole range of uncertainty. With this the precautionary approach has an overall role and provides for the control over the policy authority of risk science by embedding it into democratic deliberation in which citizens are engaged. It is most important to see that the role of the precautionary approach is reduced to the management issues in the usual approach, while it has an overall function in the constructionist perspective. As a regulatory approach to framing the descriptive tasks it requires that this framing is to realise in a most possible careful way, concerning the prospected political and policy consequences of the chosen description mode.[14]

One of the most important commitments for the constructionist approach is insisting on the need for keeping the supreme role of movements over representation and administrative action. This includes essentially that no working of specialised knowledge spheres, whether factual or normative, is accepted as independent. We saw this in respect to the essential need for collaborative discourse in framing the risk issue. The recently dominant governmental framing of safety issues proves to be problematic in this respect because it is dominantly trying to solve political issues by translating them into technical questions to be solved by experts with the aim of looking for some technological fix (quantitative risk value) as a basis for solution for these political questions, instead of keeping the technical in an alive sustained social discourse process. To put it differently, there is here some general inclination, for example by the risk regulation in the EU, to turn and reduce a social political issue into the dominance of a technical-administrative, a trial quite typical for modernity. The therapy suggested by critical STS is to keep the formal under the dominant criticism of the non-formal, the participatory discursive process, involving full-fledged public participation.

The recently emerging turn to include ethics into regulation of risk issues is identified by the report as an extension trial of the criticised administrative attitude to normative issues. What we can call "ethical fixes" is aimed at by policymakers provided for by advices by expert groups of ethicists, on which formal regula-

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[13] Unfortunately the otherwise pioneering step by the European Community that it commits itself to the precautionary approach is only made by accepting the precautionary approach as a management principle. Compare: cf. CEC (2000) European Commission, Communication from the Commission on the Precautionary Principle COM(2001), Brussels.

[14] We have no place here to show that precaution is not only to try to prevent, to avoid something but essentially is also forcare, care for realisation in the future of some value(s) engaged with. Among other things this makes avoidable the so called "paralysation danger".

tion can be based. One has to see, that, mutatis mutandis, choosing for the relevant ethics and ethical expert advice shows the same sorts of decision contingencies the factual part demonstrates. With this an extension of the method of handling controversial socio-political issues technically, by factual or normative calculations, or at least by considerations made by experts is just extended. Instead this, the report argues, first of all a full-fledged expression of normative questions, political values and democratic aspirations is needed to be systematically integrated into the course of a participatory discourse over innovation. With this it is not said that improving (ethical assessment) techniques is not of value but not the technique for the government is to improve first of all, but the democratization of innovation governance is first of all to be realised and sustained (cf. Felt/Wynne 2007, pp. 48-50).

# 6 Reinventing Innovation

We turn back finally to the main message of the report on public participation for improving the whole innovation process. The central part of the report sets up two regimes of innovation as explanatory models to justify this claim. The first is called The Regime of Economics of Technoscientific Promises, the second is called The Regime of (socio-political) Collective Experimentation.[15]

With the term "regime" the importance of the claim is indicated by the authors. What does a regime mean? Every innovation has its own specific way but, to speak in a "geographic" metaphor, they have together their overall (economic, regulatory and so forth) relatively unchanging landscape in which they have to try to realise. Below this relatively unchanging landscape it is meaningful to differentiate a middle level, the level of regimes, where any innovation occurs, but with some ordered dynamic. Regimes are innovation patterns that work successfully. Radical, breakthrough innovations are by necessity not only deep technological but also social-technological changes. These include economic impact, but also redistribution of agency and power, learning and changing social relations with the realisation of innovations. Successful innovations need a co-evolution of a supporting environment, in terms of market, consumers, legal regulation, supporting culture, etc. These are all in interaction with similar individual innovations, in an innovation regime, in which co-evolutionary processes among the technical and non-technical constituents occur. For example systematic inclusion of users into design as some sort of change on regime level redistributes agency and with it some power too, in some measure, integration of environmental considerations changes the earlier direction of innovation, etc. Models on regime level summarise the patterns of different individual innovation efforts follow.

The report, as mentioned, differentiates between two regimes, indicated above. They are some sort of ideal typical models. The first is the "economics of technoscientific promises" (ETP). What is the ETP in some more detail? The economics of technoscientific promises is, as the report defines it, the supply-based linear, science-push model. The "promise-push element" is decisive in it. The model works on a promise of solving basic human problems (health, sustainability, etc), by answering needs emerging in the market by accelerating the linear dynamic of innovation that is repeatedly triggered by new levels of scientific knowledge. However, from this perspective there is an essential barrier in the way of realization of this dynamic. This is, as we know already, the "paradox of public unease". We saw already that it is suggested by defenders of this model that "science is the solution the concerned public is the problem". The solution, according to this model, would be a changing civil society (of hungry consumers) that is simply ready to participate as consumer in an innovation friendly market and develops a culture that celebrates innovation and the growth of consumption, and provides for economic driver for growth.

This approach is based on big scientific, technological and innovation promises. But big promises are still promises and subject of expectation cycles and this way inevitably run the risk of attracting big concerns. As the report states: "This mode of governance has its drawbacks, and is a victim of self-induced hype-disappointment cycles" (Felt/Wynne 2007, p. 24). As the TEKSS report argues, the claim for upward engagement by concerned groups gets its justification at this point. Promises are contingent things and there are two contingencies to identify. The first contingency is if the promise of solving basic human problems would really be able to be realised by the linear dynamic, the second if the realising mechanism would not change the promised goals themselves.

[15] The term "socio-political" in the name of the regime is set by the group itself. Contrasting "economics" chosen to include in the name of the first regime and "socio-political" for the second appropriately expresses their difference, as the authors intend to emphasize upon. This is that the dominating view narrowly focuses on economy first and its challenging new regime focuses on the socio-political dimension first (cf. Felt/Wynne 2007, pp. 23, 25).

The report is for a different model. This is collective experimentation, the full integration of criticism made by publics with developing technoscientific promises, co-creation though criticism. This criticism includes accepting that the ETP has most valuable elements. The problem with it from the point of view of critical groups is not if it has promising elements, but the question of hegemony. Authors of TEKSS criticise the tendency that ETP is getting a hegemonic role, it starts to work as a de facto political order (cf. Felt/Wynne 2007, p. 25). Integrating collective experimentation with ETP could provide a rich basis for diversifying the innovation efforts and making them more socially robust and sustainable because of the different knowledge base and the enhancing democratization of innovation. As the report states this suggestion is similar to John Dewey's ideas on democratization of politics but applying it for politics of developing technologies (cf. Felt/Wynne 2007, p. 25).

How does this vision fit into issues in recent real practice? We are confined to two short remarks. The outlined alternative is some sort of historical conclusion of the ongoing processes of technological controversies in the last 50 years or so. Developing technology assessment into constructive technology assessment in The Netherlands, similar efforts in Denmark, widening inclusion of citizen groups in scientific research at more and more places and paved the way to change the original dynamic of innovation as a "two-track" approach to a more co-operative dynamic of innovation. The recently very quickly developing forms of "open innovation" may play an ambivalent role in helping to realise the model of collective experimentation. The reason for this ambivalence is that they focus on prospective customers and it is questionable how smoothly these two approaches can be integrated. One has to think first a basic difficulty. This is that most recent forms of "participatory open innovation" are demand side feedbacks to accelerate economic growth and rather indifferent, even when lip-service may show it differently, in such concern issues as environmental or societal long term consequences.[16] They are not for simply consuming more but concentrate on consuming differently in terms of widening experiences into the earlier unknown and over basic needs. TEKSS requires direction change for innovation. There is some direction change in integration of users/consumers but much less a direction change by integrating measures against long term negative environmental or societal consequences. From an organisational point of view, while some forms of "participatory open innovation" may easily be integrated with participation of concerned groups, others are inappropriate to this purpose. The further fate of the long term strategic vision the TEKSS report sets representing concerned actors in the innovation arena depends on how those who are engaged in the practice find strategic niches (for example, in changing energy politics, and partners and will be able to utilise them to gradually reach some stable irreversibility).

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16 As symbolic for this issue one has to think of the already very quickly extending practice to construct megaships that would carry the tourists to watch nature that very probably would be strongly, perhaps irreversibly deteriorated after a series of these types of friendly visits.

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This volume on Prospective Technology Studies includes papers from two sources. On the one side it is based on a workshop that was organized in the framework of the International Forum on Sustainable Technological Development. This Forum develops and realizes annual international workshops, one in Hungary or in Germany and then in the USA, alternating.
Some workshops have been realised and the selected materials of earlier workshops were consecutively published. For several reasons the publication of the selected presentations of the workshop in Budapest at the end of 2007 could not be published until now. Later it seemed worthwhile to unify these materials with selected presentations from the symposium on History of Prospective Technology Studies, in the framework of the XXIII International Congress of History of Science and Technology, Budapest, July 2009. That symposium was actually organized by nearly the same persons who established the Forum. Presentations from the symposium in Budapest were not only selected but some additional articles are also included. The reason is that notwithstanding good intention, not all of the authors in the current volume could come to Budapest in July 2009 to give their presentation at the World Congress. Thus, this volume entails the updated materials of these two programmes, in 2007 and 2009.

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