EUROPEAN SCIENCE FOUNDATION

SETTING SCIENCE AGENDAS FOR EUROPE

FORWARD LOOKS WORKSHOP REPORT

Looking Beyond the Endless Frontier

ESF Forward Looks Scheme: Analysis and Recommendations

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Headquartered in Strasbourg with offices in Brussels, the ESF's membership comprises 75 national funding agencies, research performing agencies and academies from 30 European countries.
The Foundation's independence allows the ESF to objectively represent the priorities of all these members.

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Foreword

Among the various instruments of the ESF, the Forward Looks scheme stands out by its double mission: on the one hand it enables scientists wishing to look beyond the frontiers of their fields to identify challenges and promising areas ahead and on the other hand it assists research organisations with setting priorities. As of January 2007, the ESF has supported 10 Forward Look exercises and is currently launching new topics.

The ESF Strategic Plan 2006-2010 foresees an increased role for this new generation of Forward Looks in setting agendas for European research. They should directly impact on European science policy enabling the development of Europe-wide research priorities and an accompanying, coherent European research funding policy. To achieve these ambitious goals, future ESF Forward Look projects must be based on a significantly advanced methodology to ensure the highest quality of advice as the condition for developing trust on the part of all stakeholders.

In this context the need to reflect on experiences of the past and current ESF Forward Looks has been emphasised. Also it has been argued that experiences of other organisations engaged in the foresight process for curiosity-driven research should be taken into consideration. To this end the European Science Foundation organised a workshop 'ESF Forward Looks: Approaches, Experiences and Perspectives' in Brussels on 29 and 30 January 2007.

We are pleased to present the outcomes of the workshop in this publication. The report by Barend van der Meulen analyses ESF experiences with the Forward Look instrument and its contexts and makes recommendations for its future development. The contributions of the speakers present a range of foresight activities from Europe and outside it*. We believe that through sharing of experiences the workshop and this publication will contribute to the development of best practices to be used by ESF and by other organisations.

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* Presentations and other Workshop documents are available on the Workshop web page at: www.esf.org/flookworkshop

Introduction

In the summer of 1967, *Daedalus*, the journal of the American Association for the Advancement of Science (AAAS), published the first materials of its *Commission on the Year 2000* – a commission of 38 members who had met only three times to produce the volume[1]. The volume contained contributions from most of the commission members and included the minutes of the three meetings held. The issue also included the first note of Daniel Bell, the Commission's chairman, to the members. In his note he listed a range of topics that he thought the commission should work on. Thirty years later, in 1997, the volume was re-published by the MIT Press because the volume happened to be extraordinarily timely. The advertisement of the book claims that:
'It is both a benchmark for the understanding of American society and a prospectus of the issues that are still relevant to the problems of today – and tomorrow'.

And indeed, though some of the wording of the problems would be different these days and there is clearly a bias towards social issues, some of the items look very familiar. We recognise themes also within the ESF Forward Looks such as the developments in biology, the environment, cultural diversity and globalisation, and the knowledge society. Compared to today's foresight activities the impact of technological developments is remarkably absent from the AAAS list.

The AAAS Commission was established at a time when the idea of forecasting was becoming increasingly popular. In France, the well-known *Futuribles* project started at the same time, and in the UK the Social Science Research Council had its Committee on the Next Thirty Years. Herman Kahn, member of the AAAS Commission published his own Framework for Speculation on the Next Thirty Three Years. In the years after the Club of Rome (1972) predicted its doom-laden scenarios based on world systems models, a new field of science labelled as 'futurology', 'forecasting' or even *'prognostica'* was established.

Since then the optimism that science would enable us to *foresee* the future has disappeared, and the ambitions of the futurology community have become much more modest. What has been maintained is the practice of expert committees that are asked for their insights into the dynamics of economy and society in order to improve policy anticipation. Furthermore, since the 1990s, a new practice of policy anticipation in relation to science and technology has developed under the idea of 'foresight'.

In 1974, national research councils, research-performing organisations and academies in Europe established the European Science Foundation (ESF) to link, on their behalf, with the scientific community at the European level. Currently, the ESF has grown to become an organisation with 75 members from 30 countries. The development of the European Research Area, and especially the ERA-Net instrument and the establishment of the European Research Council (ERC), has brought ESF to a process of redefining its role in the European research system and its relationship with its Member Organisations. From a consultation with Member Organisations it was concluded that ESF should play a stronger policy role at the European level.

Topics for the Commission on the Year 2000

1. Governmental structures including the existing federal, state, city structure and the distinction between public and private
2. Centralisation and bureaucracy
3. The influence of number: density, privacy, and interaction
4. Biological controls: genetics and personality
5. The structure of intellectual institutions
6. The adequacy of resources and energy sources
7. Population and the age balance
8. The control of the natural and human environment
9. The knowledge 'explosion' and its consequences
10. Human capital: the location and husbanding of talent
11. The consequences of meritocracy
12. The inclusion of the Negro in society
13. The use of leisure
14. The planning process and its varied form
15. The state of the international system

One of the new instruments related to the policy role of ESF is the Forward Look. This instrument was introduced in the ESF Strategic Plan 2002-2006. A Forward Look aims to develop medium-term perspectives on future directions of multidisciplinary research in Europe. Since the introduction of the instrument, ESF has had three 'rounds' in which, through different procedures, proposals for new Forward Looks were formulated and chosen. By now, several of the activities have resulted in reports and even the first impacts of some activities can be seen.

This report analyses the opportunities of the Forward Look as a policy-making instrument for the ESF and its constituencies. The report is partly based on an ESF-organised workshop 'ESF Forward Looks: Approaches, Experiences and Perspectives' held in Brussels on 29 and 30 January 2007 relating to the experiences with Forward Looks so far, and the possibilities of making use of experiences with (other) foresight exercises (*see Appendix II a*). Participants of the workshop came from Forward Look committees, ESF Member Organisations, foresight experts and ESF staff (*see Appendix II b*). This report combines the results of the workshop with general insights into the practices of foresight as an instrument for science and technology development.

1. "Toward the Year 2000: work in progress", *Daedalus*, special issue, 1967, Vol 96, No. 3, Summer

1. Experiences with ESF Forward Looks

In its Plan 2002-2006, the European Science Foundation announced a new foresight activity in order to strengthen its policy role in relation to its Member Organisations, the European institutions and the European scientific community. Up to January 2007, 10 Forward Looks had been initiated, of which seven have been completed *(see Appendix I)*. These 10 Forward Looks share some elements typical of basic science-related foresight activities, but there are also considerable differences in aim, scope, duration and methodology. This chapter gives a brief overview of the 10 Forward Looks, based on document analysis and on experiences reported at the ESF Brussels workshop. Though we have not systematically traced the influences of the Forward Look committees, the ESF Standing Committees and the ESF staff in shaping the Forward Looks, something like a Forward Looks 'practice' seems to have developed.

The first Forward Look had its main conference early in 2002 and discussed the need for better coordination of *Global Change Research in Europe*. The conference was prepared by six small teams each relating to a different area of Global Change research, which came to the similar conclusion that the use of European strengths and resources was sub-optimal because of insufficient integration at the European level. The conference resulted in recommendations to initiate European flagship projects, that ESF should establish a European Global Change Board and made analyses of four critical issues in the dynamics of Earth System Science. The final report was published in May 2003, more than a year after the conference.

Two early Forward Look activities under the aegis of ESF's Social Science Standing Committee (SCSS) indicate that the Forward Looks scheme may move easily into another form of conference grant. The Forward Look on *Cultural Diversity* was organised as a workshop only. The Forward Look on *Immigration and the Construction of Identity* was based on four workshops, each devoted to an area related to the overall topic. The two reports that resulted from these activities brought together the scientific papers and presentations from the participants of the events, but are weak in their recommendations. In the last section of the report on FL *Cultural Diversity*, the Chair of the SCSS remarked that:

'It was always intended, however, that the FL process should extend beyond the holding of a conference and indeed the output of such a conference. Extending the process requires that attention is focused on the development of an Action Plan in order to develop research goals and means of implementation'.

The fourth Forward Look, on *Urban Science*, was a collaborative effort of all five ESF Standing Committees and two COST Technical Committees (Transport and Urban Civil Engineering), and as such was an unprecedented challenge to disciplinary biases in any Forward Look. This Forward Look took the most time and lasted for almost three years. The final report will be published in summer 2007. The whole process included five workshops and a final summary conference. In this case as well, strong policy recommendations are lacking, and the report reads more like that of a scientific conference than of a foresight-like activity.

Three more recent Forward Looks are on developments and challenges in the sciences. FL *Nanomedicine* had five workshops held within five days, each with a small group of experts, and a large consensus conference with 70 participants from science, industry, foundations and governmental agencies. FL *Systems Biology* was built around three Grand Challenge meetings. FL *Nanosciences and the Long-term Evolution of Information Technology (NSIT)* was based on one 4-day conference. More than the earlier reports, these three reports set some priorities for scientific research and discussed the policy-making challenges. Each of the reports for the FL *Nanomedicine*, FL *Systems Biology* and FL *Nanosciences and the Long-term Evolution of Information Technology (NSIT)* contains concrete recommendations to improve coordination in their respective fields at the European level.

Compared to the earlier Forward Look reports, the reports of these last Forward Looks emphasise more the foresight dimensions of the ESF scheme. These Forward Looks have included some typical foresight methods. The reports reflect awareness that the Forward Look is part of broader policy-making processes. The recommendations are more focused. In FL *Nanomedicine*, a SWOT analysis was used to structure the current state of affairs and future developments and in FL *Systems Biology* a plea is made to create a 'European road map' to develop a Grand Challenge on Systems Biology. In their recommendations, the FL *Nanomedicine* and FL *NSIT* reports develop science policy recommendations and strategies at the European level. They take into account the opportunities and weaknesses of the current structures and dynamics of the European Research Area. Moreover, the priorities are more explicit in the sense that they are not just seen as new, emerging themes but as frameworks to coordinate the dynamics of these specific fields at an international level.

In 2006 three new initiatives were started: on *Food Systems*, on *Higher Education* and on the *Computational Sciences*. Methodologically, these three Forward Looks display what seems to be becoming the basic methodological framework for ESF Forward Looks: a steering group with the responsibility for coordinating the activity, a series of small expert workshops prepared through papers, and one or two final confer-

ences including policy makers and other stakeholders. In two of these Forward Looks, FL *Computational Science* and FL *Food Systems*, scenarios are developed.

For understanding the scope of Forward Looks the three are an interesting set. FL *Computational Science* addresses the developments of a scientific field that is important to the development of the sciences generally. One can argue that for the health of the science system a strong strategy in this field is of utmost importance. In that regard, the Forward Look is part of the responsibility of the ESF in relation to the scientific community. The other two are much more related to policy and social issues. The FL *Food Systems* and FL *Higher Education* are mainly foresights on socio-economic phenomena and changes. The aim of the FL *Food Systems* is to develop scenarios for the changes in Food Systems. While the definition of new research areas may be part of the outcome, the outcomes are more likely to support a European response in terms of agricultural policy than to result in a science policy strategy. The FL *Higher Education* is set up in a field in which policy and research are strongly interconnected. One of the aims of the Forward Look is to develop a future-oriented research agenda which is less driven by policy.

The differences between these three Forward Looks highlight the fact that the overall aim of the Forward Look scheme leaves room for different kinds of Forward Look activities in terms of focus on scientific, socio-economic, environmental and political changes. It is also ambiguous whether Forward Looks are aimed at responses to changes that are happening already or at anticipation of developments in the future. In the former case, a foresight of changes on a short- to mid-term time scale is appropriate. In the latter case, foresight would look at the mid- to long-term. Currently, the impression is that the more social science-oriented foresights tend to develop in the first direction: articulating changes in order to support policies and improve the science-policy link, while the science-oriented foresights tend to longer-term foresight in order to prepare the ground for the appropriate coordination of science policies at the European level.

Forward Looks are not yet a stable practice, with a set of routines, rules and methodologies that can relatively easily be used by the actors involved. We see that some elements are repeated, such as a steering board of experts, the use of small workshops with experts combined with larger conferences in which a broader expertise and other stakeholders are involved. The European context is becoming more and more defined and thus we find increasingly more options for European science policy making reflected in the recommendations. The experiences so far provide possibilities to learn about opportunities for the further development of the Forward Look as a science policy instrument. In order to do so, we will put the Forward Look experiences in context.

2. Contexts of ESF Forward Looks

The ESF Forward Look is an example of the development of foresight as an instrument for science and technology policy. Foresight developed in the 1990s from a new experimental policy instrument for national research policies into a practice being deployed in a range of R&D-related policy contexts. Interestingly enough, while in the earlier years foresight had clear links with governmental ambitions to improve allocation of research funding, including funding for basic science, the instrument has developed much more into an instrument for innovation policy. As a result, the practice of foresight seems to be much more geared to the dynamics of technology than to the specificities of basic science.

Organisations involved in policies for basic research have tried to set up foresight activities. Examples are the Royal Netherlands Academy of Arts and Sciences (KNAW), the Academy of Finland, the US National Academy of Sciences (NAS) and the OECD, though the latter do not use the term 'foresight'. These activities share with other foresight activities the fact that they bring together actors to discuss future developments in order to coordinate strategies[2]. This is a rather general description of commonalities. But it highlights three main aspects which foresight has brought into science and technology policy making: (1) notions of networking and a perceived need to collaborate; (2) the aim of developing collective strategies for science and technology investments and activities; and (3) the idea that such strategies should be based on future developments rather than on past performances.

But there are considerable differences, as well, between the Forward Looks and the more technology policy-related foresight activities in terms of methodologies, policy contexts, actors involved, implementation of results etc. In this chapter we put the Forward Looks in context to understand the specificities of foresight for basic research at the European level. We will assess three contexts:

(1) the dynamics of and developments in science, including the emergence of fields of research and the changes in the production of knowledge;
(2) the development of foresight methodologies as a possible source for good practices; and
(3) the changing policy dynamics in research systems, especially denationalisation, the development of the European Research Area (ERA), new roles of research councils and the strategic role of universities.

2. An authoritative definition of foresight is: 'the systematic attempt to look into the longer-term future of science, technology, the economy and society, with the aim of identifying the areas of strategic research and the emerging of generic technologies likely to yield the greatest economic and social benefits'. (Martin and Irvine, 1989, *Research Foresight: Priority – Setting in Science,* Pinter Publishers), but development of foresight has broadened several aspects of this definition.

2.1 Dynamics of science

'Basic science' is often used in an uncomplicated way, as if it is a well-defined category that can easily be recognised in the dynamics of research. According to the Frascati Manual, basic science is experimental and theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena as observable facts, without any particular application or use in view. The Frascati Manual is in many ways a political document, meant to create categories of research activities that can be measured in national statistics.

Today's understanding of what basic science is and how it can be best governed is very much influenced by Vannevar Bush's report *Science, the Endless Frontier*. In that report Bush advised the then US president to continue investments in science after the Second World War. While investments in science were made during the Second World War, in the context of the Manhattan project, Bush made a convincing claim that in the long run it would be more profitable to remove mission-related goals and allow scientists to allocate funding according to their own scientific criteria. In many Western countries, funding structures were implemented to institutionalise such a governance scheme, and the academic community got used to the idea that, indeed, basic science is and has to be disconnected from practical applications.

This traditional notion of basic science is at odds with the idea of foresight in order to coordinate research investments and set priorities and to do so with an eye to the future relevance of scientific developments. From parts of the academic community two objections are heard against foresight. First, that basic science cannot be predicted and planned and that any attempt will fail. Though there is some truth in this argument – as there is in the notion of the Endless Frontier – it ignores the importance of planning for scientific research itself, especially in those areas where scientific research depends on large investments in infrastructure and long-term collaborations. Typical examples include marine research, astronomy, high energy physics and climate research.

The second objection is that the governance of research through funding bottom-up defined and peer-reviewed proposals ensures that the portfolios of research councils reflect the most promising research issues and is thus by its very nature a kind of implicit foresight. Again, the strength of response-mode funding can hardly be underestimated, but at the same time, as a governance mode, it has limitations for deciding about large investments in managing the emergence of new fields of research (especially if they emerge at the overlap of multiple disciplines), and for attracting new research funds.

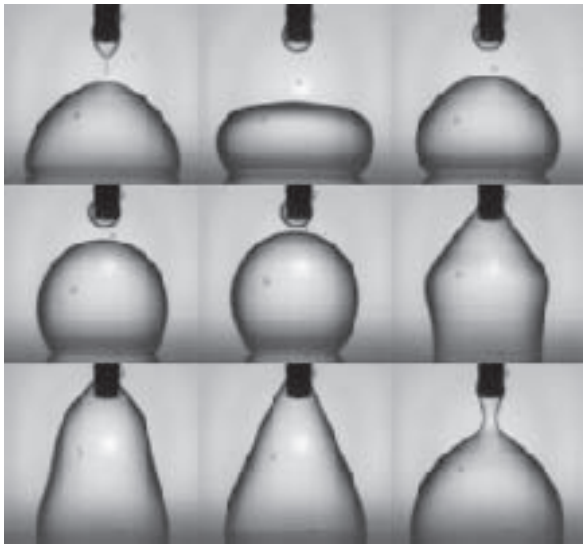

Figure 1: Dancing droplet (University of Twente, Research Group Physics of Complex Fluids, http://pcf.tnw.utwente.nl)

The implicit philosophy of science behind the idea of basic science as developed in Vannevar Bush's report is not very helpful in understanding the current dynamics of science. In fields such as the life sciences, parts of materials research, nanotechnology and most of the medical sciences we see that major investments in research are legitimised by promises that the research will result in economic and social benefits. Such promises are often much more articulated than the general claim that, by moving the frontiers of knowledge, in the end new territories of exploitable opportunities are created.

Figure 1 comes from a research project on complex fluids. It shows a dancing droplet, created by a process called electrowetting. Electrowetting is used to produce very small droplets at nano- and microscale for transport and small-scale chemical processes. The project from which this picture comes improves the production of small droplets by being able to control the charge of the small droplet at the tip of the wire. The large droplet at the bottom starts to dance or to oscillate at certain frequencies of charging and discharging of the wire. The specific technological details do not matter. The research was published in 2006 in the *Physical Review Letter*. But clearly this is not just a natural phenomenon. It is a *performance* that the researchers have created with specific applications and uses in mind: laser jet printers and medical sprays are mentioned.

There are all sorts of philosophical issues related to this kind of research. While we normally assume that the phenomena, which are analysed in laboratories, somehow reflect natural phenomena, the laboratory phenomena are not meant to reflect reality as it is, but claim to reflect a reality that will be possible in the future. And while the phenomena have an explanation, the real focus of the project and the publication is on the performance. Even though we know that there is still a gap between the performance in the laboratory and similar performances in inkjet printers. For this assessment it is sufficient to acknowledge that this kind of science and its prospective cognitive structures are typical of many current scientific developments and that the formal understandings of basic science do not apply, nor do those of applied science. Research programmes, proposals and also scientific articles are loaded with ideas of how the research will produce valuable knowledge. Moreover, if we also include in our definition of science the social sciences, economy and maybe even the humanities we find that the dynamics of knowledge are intertwined with economic and social developments.

The idea of 'strategic science' has been proposed to fill the gap between basic science and applied science. Some have suggested that such a new label was not enough and that the actual developments reflected a new mode of knowledge production or even a fundamental change in dynamics of knowledge because of its links with economic and political dynamics. In medical science, the notion of *translational research* has emerged as a new (funding) category. Concepts such as *Mode 2 research*, *post-normal research*, *Triple Helix* try to conceptualise dynamics of knowledge production in which the dynamics of basic research are interlinked with dynamics of policy making and knowledge application[3].

Such new concepts might be helpful in capturing new phenomena in science itself, but at the same time we have to acknowledge that there are still scientific activities that are very well captured by the traditional notion of basic science. What we need is not a new strict definition of science but an understanding of the differences between scientific disciplines or fields of research. The understanding of these differences is important. For some scientific developments and some modes of knowledge production, foresight is more appropriate than for others. To elaborate this insight we need to make two further steps: one is a methodological step; the other is a policy-making step.

3. See e.g. M. Gibbons et al., 1994, *The New Production of Knowledge*, London: Sage Publishers; S.O. Funtowicz and J. R. Ravetz, 1993: Science for the post-normal age, *Futures* 25:7, 739-755. H.Etzkowitz & L. Leydesdorff, 'The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University-Industry-Government Relations,' Introduction to the special "Triple Helix" issue of *Research Policy* 29(2) (2000) 109-123.

2.2 Foresight experiences and methodologies

Is the Forward Look a kind of foresight? General definitions of foresight emphasise that foresight is a *process* which aims to explore *future* developments in order to *improve* strategy or policy making. Many foresight activities do so in an interactive way, allowing multiple actors to be involved in the development of policy making or to stimulate these actors to make joint strategies. As such Forward Looks are a foresight activity.

Behind the general definitions there is a world of foresight practices in which the ESF Forward Looks do not easily fit.

In their review of priority-setting experiences in eight countries, Martin and Irvine criticised many of the activities because they were based on just the BOGSAT method, a bunch-of-guys-sitting-around-the-table[4]. They contrasted this dominant approach in Western science policy with the Japanese Delphi studies. In these Delphi studies a large number of predictions about future scientific and technological achievements were proposed to experts, which would give, in two rounds, their assessments about the likelihood of these achievements and the timing and importance and difficulties of realising these achievements. Contrasted with the panel approach, Delphi studies were more forward looking, included more actors from different constituencies and created a larger commitment among those involved to act upon the results. Several of the foresight activities in the early 1990s adopted the Delphi approach, such as the UK Technology Foresight and foresight activities contracted to the German Fraunhofer Gesellschaft. Recent foresight activities display a much wider range of methodologies. Delphi studies still occur, but scenario building, road mapping, panels, different forms of interactive workshops, essay writing, key-word analyses, back casting are used more often.

The choice of methods is really a balancing act of resources, competencies, aims of the foresight, opportunities to involve other actors, timing etc. Basic science organisations still tend to rely heavily on panels of scientists when initiating foresight activities. Though this ensures the expertise level, panels are not well known for their interaction with external actors or for their creativity. Experiences in other foresight activities show that interactions within the panel often create a strong commitment of the panel members to the conclusions. But the external legitimacy of the results is often low, especially if the panel meetings have not been accompanied by strong interactions with the main stakeholders. Panels also tend to be rather reluctant to make ground-breaking statements, even if their members are scientists working at the cutting edge of the scientific frontier. The same members are sometimes much more provocative and creative when they are asked to put down their visions in an essay.

Each of the methods has its specific strength and weaknesses for specific aspects of foresight activities. Table 1 gives an overview of Dutch foresight experiences in science and technology policy in the 1990s with a range of methods[5]. The original overview distinguished expert-based and creativity-based methods.

Table 1: Strengths of foresight methods in terms of five methodological aspects of foresight processes

Method	Expertise input	Enhancing creativity	External interaction	Strategy development	Dissemination of results
Expert-based methods					
Panels	●●●●		●	●●●	
Essays	●●●	●●			●●
Delphi method	●●●	●		●	●
Indirect expert methods					
Surveys	●●				
Interviews	●				
Review studies	●●			●●	●
Bibliometrics	●●			●	
Interactive methods					
Conferences	●		●●		●●●
Workshops	●●	●	●●●	●	●●
Brainstorm sessions	●	●●	●●		
Strategy making					
Scenario studies	●●	●●		●●●	●●●
SWOT analysis	●	●	●	●●	●
Road mapping	●●●		●●	●●●	●

Increasingly we also find strategy-oriented methods such as SWOT analysis and road mapping and scenario building being used. The table scores each of the methods on three aspects of foresight that most methodological reviews emphasise: (1) the need for expertise; *and* (2) creativity to develop reliable and challenging future prospects; and (3) the interactive component of foresight to ensure breadth of expertise and commitment[6]. For reasons of policy implementation it also scores the methods on the contribution of results to (4) strategy making and (5) the inherent dissemination of results.

Foresight in basic science cannot work without the commitment of scientists, and a high level of expertise is a prerequisite for both reliability and commitment. An example of a well-defined practice based fully on the expertise input from a panel is the reviews, advisory studies and foresight-like activities of the US National Academy of Sciences (NAS). The purposes of the studies are: (1) to stimulate new funding options; (2) to organise the delivery of results of science and engineering; and (3) a better planning of resources. Each of the studies is done by an expert committee supported by the scientific staff of the NAS. The NAS produces 200-300 reports a year, of which some are similar to foresight reports and address issues on the development of fields of research. The quality of the reports is ensured both through careful selection of committee members and an external review of the draft final report.

Increasingly, foresights make use of formal interactive, prospective methodologies to structure the interaction within workshops. Many scientific developments come with implicit scenarios about the future. In some fields of engineering science expectations about scientific and technological developments have been made explicit in scenarios or in technology road maps. EU-funded ICT research and the national programme in the Netherlands are based on a Freeband scenario, new ICT infrastructure and applications without restrictions of bandwidth. The nanotechnology programmes have application prospects such as a lab-on-a-chip and molecular drug delivery.

An interesting foresight activity in this respect is the *Towards 2020 Science*, initiated by Microsoft Research Ltd.[7] in 2006. Thirty scientists from the main scientific disciplines were brought together in a workshop to develop, through brainstorming and formal road mapping techniques, a Draft Road Map which displays the main goals, scientific challenges, computer and computational infrastructures and strategic issues for the next 14 years. The report is explicitly not a final report. The aim is that it will facilitate the communication about '*making concrete an ambitious, bold but realisable vision of the aspirations of science towards 2020.*'

Examples of NAS foresight-like studies

2000	Scientific Frontiers in Developmental Toxicology and Risk Assessment
2001	Astronomy and Astrophysics in the New Millenium
2003	Beyond the Molecular Frontier: Challenges for Chemistry and Chemical Engineering
2003	Frontiers Polar Biology in the Genomic Era
2003	Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century
2004	Getting up to Speed: the Future of Supercomputing
2006	A matter of size: Triennial Review of the National Nanotechnology Initiative
2006	Visualising Chemistry: the Progress and Promise of Advanced Chemical Imaging

Another example is the Technology Road Map for Catalysis research, which the Dutch research council NWO initiated in 2000. This exercise resulted in a report in which research and development strategies for the future were outlined to meet a number of high priority research goals. In order to turn the recommendations of the Technology Road Map for Catalysis into reality, Advanced Chemical Technologies for Sustainability (ACTS) was founded early 2002[8].

We cannot expect foresight in all disciplines to be such as that in engineering. Ageing, globalisation, and intercultural communications need different kinds of development from the development of ICT or catalysis. If seen as problems, one cannot simply cope with them by producing road maps towards solutions with social science as the source of the required policy steps. Nevertheless, these fields have implicit notions about the future. The phenomena they study are not just static facts, but challenge our perception of society, sociality and social phenomena. The research increases our understanding of the changes and also alters (improves) the way society copes with the issues. The interaction

4. Martin and Irvine, ibid.
5. Barend van der Meulen, 2002, *Methodiek Verkenningen, naar een ontwerpbenadering voor het opzetten van een verkenning*, Amsterdam: KNAW. (in Dutch)
6. See e.g. Ian Miles, Michael Keenan and Jari Kaivo-oja. 2002, *Handbook on Knowledge Society Foresight,* http://foretech.online.bg/docs/EFL_Handbook_October.pdf; Jerome Glenn and Theodore Gordon, *Futures Research Methodology,* United Nations University Millenum Project, CD-ROM version 2; Online Foresight Guide, Forlearn project: http://forlearn.jrc.es/index.htm.
7. Microsoft Research, *Towards 2020 Science*, Microsoft Corporation, 2006
8. See: http://www.nwo.nl/nwohome.nsf/pages/NWOA_6P69ZX

of social science with social developments is of a different kind than the interaction between engineering science and technological developments. One way to translate the relationship into foresight is by the use of scenario techniques in which multiple scenarios are created. The Royal Netherlands Academy of Arts and Sciences (KNAW) and other Dutch bodies have practiced this technique in some of their foresight activities. Instead of one scenario or a road map that aims to converge strategies of stakeholders, such sets of scenarios can be used to highlight the key issues related to socio-economic developments.

What about a field such as astronomy? Do we need foresight in a field which indeed does not hold any view on application or use, as formal definitions of basic science suggest? The NAS has a large number of publications on astronomy and related subjects, reflecting a longstanding planning tradition in that field. The first reports go back at least to 1982, when NAS published a two-volume report on a strategy for astronomy for the 1980s[9]. In 2003-2004 the OECD Global Science Forum organised two workshops on future large-scale projects and programmes in astronomy and astrophysics. The workshops were attended by scientists and programme managers from 17 countries. The result was a consensus report which underscored the need for international coordination and contained recommendations for both governments and scientific organisations[10].

Apparently we see here a function of foresight for basic science which is rather independent from cognitive differences, but related to the increasing need for priority setting and investments and infrastructure planning in order to cope with increasing costs and create a viable research environment. The work of the ESF's own Marine Board, which published in 2006 its third *Navigating the Future* report, is also an example of this kind of foresight[11].

2.3 Policy contexts

The first foresight activities were initiated in the context of national science policies. In the early 1990s, governments articulated their responsibilities towards the science system more prominently. New policies and policy concepts such as New Public Management, national systems of innovation, and the knowledge society came with restrictions on the traditional budget streams, priority setting at the national level, new investments and funding instruments related to these national priorities, and increasing pressures to improve the links between basic science and socio-economic benefits such as innovation, health, environment, social cohesion and security. In many countries this has led to a redefinition of the role of national governments *and* national funding bodies in the research systems.

National foresight studies initiated at the governmental level still occur, but foresight has moved to other science policy levels as well, such as the intermediary level – the level of research institutes and within sectors. National foresight studies are currently less focused on priority setting than the national exercises were in the early 1990s. The main aims of national foresight activities are the development of a shared vision for actors in the national innovation system and, through such visions, to create better links between the different constituencies of the innovation system. For academic research such exercises often imply the formulation of research areas that are of socio-economic and ecological relevance. At the intermediary level, such as the research councils, academies and technology agencies, foresight studies often serve to set priorities for funding allocation (research programmes) and the selection of larger investments (centres of excellence, infrastructures). Sector foresights often use foresight to align strategies of heterogeneous actors who depend strongly on the health of the sector and, consequently, on each other. Foresight may help to identify areas for strategic collaborations.

The different levels refer to different roles, hence objectives, methods and results of foresight used for strategic policy making are not the same[12]*.*

In all three cases the foresight tends to emphasise national dimensions of scientific research, especially when even bodies at the intermediary level emphasise their national functions. An example is Finnsight 2015, a joint initiative of the Academy of Finland and TEKES, the Finnish Funding Agency for Technology and Innovation[13]. Note that this activity was both a national study as well as being linked to some clear implementation opportunities at the intermediary level. For the Academy, the results are relevant as a general strategic input, while TEKES used the results to select new Centres of Excellence. The foresight activity, which ran from September 2005 until March 2006, was organised through 10 panels, each with 12 members from science and industry. The focus of the 10 panels in itself already reveals some of the driving socio-economic

9. Astronomy Survey Committee, National Research Council, *Astronomy and Astrophysics for the 1980s*, 1982, NAS Press, Washington D.C.
10. OECD Global Science Forum, *Workshops on Future Large-Scale Projects and Programmes in Astronomy and Astrophysics*, September 2006, Paris: OECD.
11. ESF Marine Board, *Navigating the Future-III*, Position Paper 8, November 2006, Strasbourg: ESF.
12. Handout Remi Barré at the ESF Forward Looks Workshop. See: www.esf.org/flookworkshop
13. See: www.finnsight2015.fi

Panels of Finnsight 2015

Learning and Learning Society
Service and Service Innovation
Well-being and Health
Environment and Energy
Infrastructures and Society
Bio-expertise and Biosociety
Information and Communication
Understanding and Human interaction
Materials
Global Economy

forces of Finland and emerging areas of science and technology. Typically, such national foresights imply the involvement of a large number of actors. Finnsight 2015 realised this through the use of the networks of the panel members, and through the use of several Internet-based tools. From the results of the 10 panels five issues were singled out:

(1) the management of global risks;
(2) energy and environmental issues;
(3) the renewal of the health care system;
(4) ICT applications; and
(5) bioscience applications.

The report emphasised that all of these areas require science and technology cooperation that is based in human need, reflecting the overall aims of national foresight to improve the relations between science, technology and society.

The development of foresight as a policy instrument strengthening national strategies goes with processes of denationalisation of the organisation and funding of scientific activities. The increasing cost of research equipment has been an ongoing driving force for the development of international programmes and facilities, as is the development of international political and scientific issues. In other fields with stronger national orientations, the pressure to perform has increased the volume of international publications. In some countries, universities have become more independent of national governments and this has increased their opportunities to compete at an international level and attract excellent researchers.

The development of the European Union Framework Programme has, through mobility schemes and research programmes, added a strong international dimension. The European Research Area is still far from a steady state and initiatives such as the European Research Council may induce new unexpected shifts in what national governments still tend to see as 'their national science base'. Clearly the EU Framework Programme and its specific instruments provide a context for follow-up activities and implementation of results (ERA-Nets, networks of excellence, research programmes, collaborative projects).

Within the new configurations, one may question what role foresight should have. Clearly, the idea of organising research activities in a national context and linking them to nationally defined priorities can hardly withstand the current forces of internationalisation. On the other hand, uncertainties for research organisations are increasing and foresight might help to define organisational strategies. An example of such a foresight is INRA 2020, a two-year process in which the organisation assessed its future strategic room for manoeuvre. The process consisted of three phases: (1) debates about INRA's future including 2000 of its employees; (2) development of scenarios of the organisation's context in 2020 and scenarios for the development of the organisation per se; and (3) a strategy phase in which principal results were discussed with the organisation's governing bodies[14].

In a European Research Area in which many academies, research-performing organisations and research councils fulfil similar functions, foresight may also be used to align strategies of related organisations on certain topics. Foresight might be a coordination instrument for organisations such as the ESF by which its members can develop joint funding programmes. Often these funding programmes address scientific developments or social issues of which the impact and nature go far beyond the national borders that define the working space of the members. Many ESF members are confronted with budget limitations that prevent them from creating funding programmes of any sufficient critical mass.

A third function remains to improve the links between scientific activities and social, economic, technological and environmental developments. Linking policy and basic science is a sensitive issue. In some national innovation policies such links are promoted in order to shoehorn scientific research into the national policy and economic priorities. Such policies often ignore the specific dynamics of science and suggest that they can be easily planned and structured at national levels. If science organisations induce foresight activities we might escape from over-optimistic ideas about the contribution of science, simplistic visions of the future of technology or doom-laden scenarios about our global cultural interactions and instead achieve a more reflective understanding of possible future developments and their relation to ongoing science and technology.

14. Bertrand Hervieu, Jean-Claude Flamant, Hugues Jouvenel (eds.), *INRA 2020. Alimentation, agriculture, environnement : une prospective pour la recherche*. INRA, Paris, 2003. See also: http://www.inra.fr/presentation-inra/INRA2020_1.pdf

For each of these functions the issue of implementation is of great concern. Foresight is not known for implementation of the results. Indeed studies of implementation of foresight results show that *direct* implementation of priorities and recommendations is a rare phenomenon[15]. More often the results become part of policy-making processes which are hard to steer by just a report. There is a strong tendency within foresight, both in the methodologies and in discussions about its aims, to emphasise the process of developing future visions and the interactions among participants. Products such as reports, lists of priorities and recommendations would be only steps in such processes. Still, it is too easy to give up the idea of implementation. Instead, foresight should be more strongly integrated into the overall development of science policies. Foresight can then be seen as a policy-making instrument.

This has several consequences. First of all, if foresight processes are considered to be valuable as such, process results should be formulated in the design of the activity. If interaction, networking and the creation of new collaborations are seen as necessary, then the events should be organised in such a way that new relationships can be built. In that case foresight is not so much an activity to inform and improve policy making, but an instrument for coordination per se. However, in many scientific fields such interaction does already occur and the aim of foresight can be more ambitious and can be formulated in terms of strategy development.

Second, in order to increase the opportunities for implementation, foresight activities need to build upon some sense of urgency. There is no reason to develop an approach which covers all fields of research and all socio-economic sectors for foresight[16]. In some fields the need for foresight emerges almost by itself and is identified by researchers; for example because they realise that some sort of coordination might help further development in the field. In other fields, external pressures and developments may induce strategic uncertainties or new opportunities. Foresight may help to assess the consequences of such developments.

Third, if reports are not final products but an attempt to initiate or coordinate science policies, the reports should have sufficient 'policy force'. Its function would be not to report all discussions at workshops and events in detail, nor to publish all the papers presented. Instead it should translate such inputs into a vision of the development of research fields that can be used for strategy making by science policy bodies. Concrete recommendations may be useful, but if a broad range of science policy bodies are addressed (e.g. at national and international levels) it is even more important that a vision is created that can be used to legitimise new science policies.

2.4 ESF Forward Looks as a foresight practice

If we define Forward Looks as another form of foresight, it is appropriate to examine its nature more specifically. Such a definition is not just something rigid, but serves to develop a recognisable foresight practice which helps to build up legitimacy for the foresight results and facilitates cross-FL learning about the pros and cons of certain methods and approaches. It also helps the ESF to position Forward Looks in its own portfolio of instruments and in relation to its policy role at the European level.

Forward Looks have some specific characteristics which makes it different from other foresight exercises. First of all, the policy context of the Forward Looks is more complex than many national or organisational foresight studies. At the ESF Forward Looks Workshop Remi Barré[17] presented three levels of foresight:

(1) National foresight activities aiming to inform national policies;
(2) Foresight activities at the intermediate level that often focus on specific fields of science and technology or at specific sectors. These foresight activities often aim to induce some concerted action at field or sector level;
(3) Organisational foresight at the research-performance level to improve the strategic positioning of organisations.

ESF Forward Looks are not located at any of these levels, though through the ESF Member Organisations there is some linkage to the intermediate level. More importantly, the Forward Looks do not have a 'natural' policy environment and thus lack a regular implementation structure. The European Research Area may develop as the policy environment for the Forward Looks. The ERA is still in development and Forward Looks may help to shape the ERA for emerging areas in science[18].

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15. Barend van der Meulen, 1999, The impact of foresight on environmental science and technology policy in the Netherlands, *Futures*, 31, 7-23; Michael Keenan, 2000, *'An Evaluation of the Implementation of the UK Technology Foresight Programme'*, PhD Thesis, PREST, University of Manchester; Barend van der Meulen, 2003, Developing Futures for the Agriculture in the Netherlands: a Systematic Exploration of the Strategic Value of Foresight, *Journal of Forecasting*, 22, 219-233.
16. Note that the national foresight activities tried to do so in the early 1990s. The Dutch foresight process resulted in quite uneven activities, with even artificial attempts to initiate foresight in areas which were not 'ready'.
17. See footnote 12.
18. See the HLEG report to the EC *'Thinking, debating and shaping the future: Foresight in Europe',* 25 April 2002. For an overview of initiatives to use foresight at European level see: http://www.efmn.info/about/platform.shtml?s=8259DBD6-7D7417220208-670A

Second, more than other foresight activities, Forward Looks are assessing the dynamics of science at or beyond the frontiers of knowledge. While many other foresight activities are inspired by the progress of knowledge and take its impacts as input for developments in technology, economy, society etc. the Forward Looks attempt to develop visions of the future dynamics of science itself. The input for the assessment is generally today's scientific agendas and performances, and not external inputs of, for example, policy, economy and society.

Methodologically we see that the Forward Looks rely heavily on the inputs of scientists and are based on inputs (presentations, papers) and processes (workshops, working groups) that are similar to regular scientific communications. Typically, the output is a report which is distributed to the stakeholders, sometimes supported by presentations by members of the working group responsible for the report. Only to a limited extent are non-academics involved in the workshops and non-scientific developments are considered as an input into the foresights.

The value in terms of outputs and impacts of the different Forward Looks is very different. It depends to a large extent on the subject of the foresight activity and on the efforts of the members of a Forward Look committee to plug the report into different policy processes.

In conclusion a Forward Look can be defined as an interactive process by which scientific challenges and opportunities in fields of basic science are explored and which aims to identify needs and opportunities for improved science policies for such fields. Science policy implications may be formulated at the level of research strategies of scientific groups, national funding agencies and/or international science policy bodies. While the Forward Look still lacks a natural policy environment, in the near future the development of the European Research Area might provide such a policy context for most of the Forward Looks.

3. Designing ESF Forward Looks

In Chapter 1 we articulated some learning experiences for Forward Looks and some elements of what could develop as a specific foresight practice. One can build upon the expertise of scientists within foresight panels and workshops, and on conferences for interaction with policy makers of various kinds. At the same time, recent Forward Looks show quite some variety in their aims and objectives. In Chapter 2 three contexts of the Forward Look were assessed: the context of the dynamics of science and technology, the evolving methodologies for foresight and the policy contexts. We have also formulated a core function of the Forward Look in the final paragraph of Chapter 2.

Chapter 3 will articulate elements of 'good practice' for the next generation of Forward Looks. Such a good practice does not imply a one-size-fits-all approach. On the contrary, a too-rigid standardisation would ignore the differences in dynamics of scientific fields and the differences in science policy needs and opportunities. For developing a good practice, the organisation of Forward Looks should be considered as a *design issue*. In order to have a Forward Look that does what it is aiming at, one needs to carefully develop the Forward Look within its specific context. The key to a design approach is that any Forward Look functions in a context and, like any design, will deliver only if there is a good fit between process and context. This can be achieved in two ways. First, by a framework for developing a Forward Look based on a set of *design questions*. Second, by structuring the process of a Forward Look and formulating good policies for the different steps in the process.

3.1 Design questions

At the heart of the design approach are five *design questions*. The answers to these questions define the function of the foresight and the appropriate methodological approach. For each Forward Look it is important that these questions are answered at an early stage. Without this happening, it is almost impossible to define a clear task for a Forward Look committee.

1. What are the characteristics and dynamics of the field that is foresighted?

A main distinction in the current experiences is that some of the Forward Looks look at socio-economic issues that are known. A Forward Look is appropriate if basic research can improve the understanding and, as a result, the way society copes with these issues. A Forward Look may try to improve the basic research investment in that field; examples are 'changes in food production' and 'higher education in a knowledge society'. Other Forward Looks examine emerging scientific fields and try to understand their scientific and socio-economic impacts. Clear examples are the two Forward Looks in the nanotechnology area.

These are two really different approaches for developing directions for science policy. Both are valuable, but each brings its own methodologies and implementation. The Forward Looks relating to socio-economic issues will in general:

- look at short- and mid-term developments;
- cover a multidisciplinary scientific area;
- need participation from non-academic experts into the whole process; and
- deliver results which give direction to policies for science and for policies on science for policy.

The Forward Looks that address the impacts of emerging research areas will in general:

- look at mid- to long-term developments;
- address developments at the frontiers of two or more disciplines;
- rely on input from scientific experts; and
- deliver results that can be used to optimise the set of possible policy instruments for the new field of research.

There is a third kind of scientific field, where the dynamics are dependent on large infrastructure and, because of scale and costs, on international collaboration. The ESF Marine Board and also OECD and NAS show that research foresight is a valuable instrument for coordination of such fields. Such foresight exercises will usually include the main policy bodies in a particular field and will have more specific aims such as priority setting and decision making on infrastructure than the current Forward Looks.

2. What is the main question or problem that makes a foresight needed or appropriate?

From the experiences so far and the discussions in the workshop, at least three kinds of situations can be distinguished.

(1) The issue or field that is foresighted is rather unknown. Nanomedicine was probably such an issue when the Forward Look was initiated. Negative examples can be found in the early days of nanotechnology. In several countries, foresight activities indicated the importance of nanotechnology, but the signals were not disseminated[19]. One of the functions of the foresight will be to raise awareness, and merely the acknowledgement among a wide set of policy and academic bodies that the issue needs to be addressed can already be an important result. For the Forward Look process it is important that in the last phases a strong emphasis is

19. Work in progress Frank van de Most, PhD research University of Twente, the Netherlands.

put on the inclusion of other actors in the activities. In this kind of situation one may also expect that dissemination will be an important issue for the implementation phase.

(2) There is an emerging issue. It is likely that in certain institutions policies have been developed, but the scale might be too small, or local responses to the development are insufficient. Forward Looks may build on these local initiatives and use their initial results as input into strategy making at the European level. Implementation may need a long trajectory in order to raise awareness that European coordination may be valuable and to create the proper implementation results. An example seems to be the new Forward Look *RNA World: a new frontier in biomedical research*. As the abstract of the Forward Look explains: '*The integrative aspect of this FL activity is much needed in a research field consisting of highly specialised domains and is expected to generate awareness of the progress in RNA research and to foster European research programmes in member countries'.*

(3) The importance of the issue is widely acknowledged and thus many socio-economic, political and scientific actors will have contributed to the issue. The possibilities for the ESF to play a key role are not many, but analysing emerging issues for scientific research might improve the level of the debate. Urban studies seems to be in this category. The scientific and policy importance of this discipline is widely acknowledged. The workshops of the FL Urban Studies explored important urban issues and stimulated novel thinking about them. Typically, Forward Looks in such areas will bring a wide range of actors together and use the proper instruments such as road maps to translate ongoing issues into a scientific agenda.

3. Can any sort of implementation of the results be expected and, if so, who should take care of implementation?

Forward Looks have the general aim of directing science policies. That is a formulation that covers many possible policy instruments and policy actors responsible for implementation. The experience with foresight in general is that the likelihood of implementation of results increases dramatically if key actors have been involved in the foresight process. Especially in a phase when policy options are assessed, the inclusion of key policy actors may be crucial for the success of implementation. From a process perspective, one can even consider the last steps of the foresight process as the first steps of the implementation process.

Five design questions for Forward Looks

1. What are the characteristics and dynamics of the field that is foresighted?
2. What is the main question or problem that makes a foresight needed or appropriate?
3. Can any sort of implementation of the results be expected and, if so, who should take care of implementation?
4. What expertise is needed to discuss the developments in the field and to what extent are external perspectives needed?
5. What kind of specific interests or obstacles may be expected in the conduct of the foresight or in implementing the results?

4. What expertise is needed to discuss the developments in the field and to what extent are external perspectives needed?

The quality of any foresight exercise, and certainly of Forward Looks which are conducted in a scientific arena with high quality standards, relies on the input of experts. A key question in developing a Forward Look is what kinds of expertise are related to the issue that is foresighted. It goes without saying that a Forward Look process needs to cover the different expertises. If the topic of the Forward Look is a scientific topic, the expert input will come from scientific experts (who do not all necessarily have academic positions. In some areas the scientific expertise in industry is as high as in academia). In the case of socio-economic developments, experts may also hold social positions and such actors may have valuable perspectives on the issue and the possible role of basic science.

External views may increase the quality of foresight exercises. Especially in the first steps of the foresight process it might be very valuable to organise external, and maybe even deviant, perspectives on the foresighted area. Eminent scientists from adjacent disciplines, non-European experts, experienced science-policy actors, research directors from industry may have visions that enrich the framing of the issue.

There is a second reason to organise such external views. Research foresight has a reputation for tending towards advocacy; that is, scientists using the exercise to defend their vested interests rather than exploring new developments, creating new links with other disciplines or being responsive to possible changes. For the legitimacy of the Forward Look as a policy instrument, such a move toward advocacy is to be avoided. Bringing external views into the foresight process may balance any tendency towards self-interest.

5. What kind of specific interests or obstacles may be expected in the conduct of the foresight or in implementing the results?
Forward Looks organise a process of strategy formulation that usually depends on many unknown and uncontrolled factors. In the multi-actor, multipolicy-level environment in which the process is conducted, all kinds of things may happen that obstruct the foresight process. Key actors may feel threatened, or may try to capture the process for their own interests. Policy bodies that are seen as crucial in the implementation may refuse to take part in the exercise. Within the scientific community there may be rival schools of thought or even personal rivalries that may trouble workshops and conferences. Answers to this fifth question will usually not result in a positive recommendation for the foresight process, but the acknowledgement of such obstacles at an early stage may avoid frustration during the process.

3.2 Defining subjects for ESF Forward Looks

The topics of foresight present themselves in a well-defined policy context. For the ESF it is less obvious how best to select the topics out of a sea of scientific developments. Today's science has not just one frontier but progresses in a countless number of fields, and each frontier has its own dynamics. One can think of Forward Looks defined by disciplinary agendas, interdisciplinary interactions, socio-economic or environmental needs for basic research, policy challenges of Member Organisations etc. The three rounds of Forward Looks the ESF has initiated so far have had three different procedures for selecting the topics of foresight (1) The ESF has asked its Standing Committees to suggest topics for Forward Looks; (2) it has had a call for proposals among researchers, inviting them to suggest topics for foresight, as if it were funding for networking or research; and (3) the Member Organisations were consulted for topics.

When researchers are asked to come up with proposals, one might expect that the topics suggested are related to the challenges felt at the research performance level. Innovative scientists tend to identify possibilities for new fields of research always earlier than organisations will. Forward Looks can support them in articulating these new opportunities and translate the signals at the research performance level into signals for science policy making. The typical example presented at the workshop is the Forward Look on *Nanomedicine*. That case also highlighted another more practical advantage of this procedure: members of the Forward Look committee will have a direct interest in the results and will be highly committed to the quality of results and realisation of concrete impacts.

However, the researcher-oriented procedure needs to be balanced in two ways. The ESF should, in its selection procedure, be aware that not all proposals will reflect the purposes of the Forward Looks, nor that the methods suggested in proposals are the most appropriate ones. Therefore any selection procedure for Forward Looks based on external input should include opportunities for the ESF to shape proposals to the aims of the Forward Look and to the experiences with earlier activities *(see also 3.3 Methodologies)*. There is a more active role here for the ESF Standing Committees and the ESF Office than in the usual selection of research proposals.

The second balance relates to the kind of topics identified. Selection of Forward Look topics based on proposals submitted by researchers is not the most appropriate procedure to identify topics closely related to science policy issues such as interorganisational coordination of research infrastructure, the role of international research facilities, or possibilities for coordination of research efforts in topical national priority areas. Such topics tend to be identified earlier within the ESF Standing Committees or by the Member Organisations. Organising selection procedures for this kind of topics is more difficult as proposals of this kind are more heterogeneous and the appropriateness of topics depends on the policy momentum.

There are two ways of managing such issues. One is that the ESF, within each selection round, adds a limited number of topics with a stronger science policy focus when ESF Standing Committees or Member Organisations express a well-defined need for such a Forward Look. The second one is that every third year ESF will have a specific selection procedure based on consultation with its Member Organisations and other stakeholders. This has the disadvantage that for science policy-oriented issues which are ripe to be foresighted, the momentum might have passed by the time the ESF is ready to accept such issues.

Recommendations:

- ESF is recommended to have one selection procedure for Forward Looks, which concentrates on seeking bottom-up proposals from researchers.
- Include in the selection procedures or the implementation procedure a phase in which, if needed, the proposal is shaped towards the aims of Forward Looks and towards best practices/experiences with Forward Looks.
- Include in the selection procedure the possibility for ESF Member Organisations and ESF Standing Committees to suggest Forward Looks if there is a clear science policy opportunity related to the European science policy role of the ESF. Do not organise separate selection procedures for such topics.

3.3 Methodologies

At the core of most of the Forward Looks are:
(1) a panel or Forward Look Steering Committee responsible for the overall process and integration of results;
(2) several workshops in which experts discuss, in-depth, the future developments of a field; and
(3) at least one consensus conference in which the results of the expert workshops are discussed among a broader audience.

The advantage of this core is that it is close to scientific practice and can easily be deployed in several fields. Workshops and consensus conferences need well-prepared inputs and should be structured in a way that interaction is facilitated and discussions focus on the right issues. Workshops and conferences may have different kinds of participants. The *design questions* may help to identify the right participants.

At first sight, there is nothing methodologically special about organising such workshops – but there are some risks. One evident risk for basic science foresight is that the workshops may develop into scientific workshops in which the future visions and strategic issues are overshadowed by substantive scientific discussions. Another weakness can be that some participants dominate the discussion or, formulated differently, that some participants are not vocal at the event. For some issues and interactions more time or more workshops might be needed to build sufficient trust for everybody to speak out.

Success of foresight workshops depends on a well-prepared input, clearly formulated objectives known to the participants, well-balanced participation and a good balance between formal and more informal sessions, between substantive and strategic discussions and a mixture of personalities.

In addition to the three core requirements, there are several methods that can be used to improve the interactions at workshops and the conference or to translate workshop and conference results into a form by which the conclusions can be disseminated easily. Typical examples include the use of scenarios, road mapping, Internet surveys and SWOT analysis. There is no need to include these methods in the standard package of Forward Looks. Some Forward Look committees will take up these methods independently, as has been done occasionally in earlier Forward Looks.

Steering Committees may in general be seen as competent to steer the foresight process. The experience with Forward Looks and with other foresight processes is that usually these processes start with a high level of uncertainty about the specific aims and tasks. The job of Steering Committee members can be easily facilitated if, at that stage, they are supported by ESF Office staff that:

- can explain the general aims and ambitions of Forward Looks;
- has insight into experiences with earlier Forward Looks;
- can ask the right (design) questions to organise the process; and
- can suggest specific features of the process that enhance the quality, such as the inclusion of external perspectives, the organisation of sufficient interaction and inclusion of implementation actors etc.

Recommendations:

- Require each Forward Look to have a Steering Committee, that a number of expert workshops are held and at least one consensus conference is convened. In addition, make use of interactive methods for foresight when this is appropriate.
- Require that each activity is well prepared in the sense that it is clear why the activity is being held, what the expected outcomes will be, and that the necessary skills are available to organise interaction and debate among participants.
- Staff of the ESF Office should be involved in the early stages of the Forward Look to assist the Steering Committee in developing the process and transfer learning experiences from earlier Forward Looks.

3.4. Outputs and impacts

Though foresight is usually seen as a process, the normal Forward Look will have an identifiable output: the report. It is clear that these Forward Look reports will differ from scientific reports which aim at reporting scientific conclusions of workshops and conferences for the benefit of a scientific audience. A Forward Look report needs to convince in a policy context and therefore needs to link its arguments and recommendation to a policy discourse. Usually this means that the report should address scientific considerations in a way that is understandable and challenging to a broad audience, and that it should bridge the scientific issues with considerations of a socio-economic and policy nature.

Some organisations have a peer review process attached to the publication of the report. Peer review is a specific form of quality control which is needed when the understanding of the contents and the assessment of the validity of the statements can be controlled only by the experts. Peer review may also be needed when the process of compiling the report includes no real external input and little interaction among the different

actors. Third, peer review is needed when the report and its argument relies heavily on the interpretation of scientific issues.

For most Forward Looks this will not be the case, or should not be the case. Ideally, those actors most likely to operate as peers will, in one or another role, have been involved in the Forward Look. The report is not the result of a small group of researchers but a collective result of those who have participated in the workshops and conferences. Moreover, if the nature of the report is so specialised that the quality control cannot be undertaken by members of the Standing Committees themselves, one may doubt whether the report will be convincing in a policy context. This is not to say that a review of reports is not needed, but that such reviews should be the responsibility of the Standing Committees, or appropriately qualified external people.

It is difficult to say anything systematic about the impacts of foresight. Research on impacts has shown that once the reports are out, recommendations are seldom followed up directly. The main impact is to be expected in the acceptance that the foresighted areas are indeed of importance and that some sort of action is needed. This may take several years as, usually, real impacts need to wait until there are windows of opportunities within the policy process.

Wait and see is an understandable but wrong conclusion arising from this unpredictability. Instead, ESF should be active in promoting the Forward Looks as valuable inputs into science policies. One may expect that the chair of the Forward Look committee and the members have an interest themselves in promoting their vision and recommendations. In addition, the Standing Committee should have a responsibility for the implementation trajectory after the report has been published. After all, the report is published as an ESF report.

The responsibility of the Standing Committee can be organised systematically in two ways. First, directly after the publication of the report, the Standing Committee should discuss the opportunities for implementing the report. This discussion should not be limited to the direct recommendations but should also relate to the general consequences of the report. Standing Committee members may highlight opportunities other than those which the Forward Look committee has seen. The result is an implementation plan which highlights the main opportunities for implementation and the possible actions that the ESF and its Member Organisations can take to facilitate implementation. The implementation plan should be discussed with Member Organisations in order to seek their commitment to the recommendations.

Second, after the two years, ESF staff should write a monitoring report in which it reflects upon the implementation trajectory and formulates lessons about the whole Forward Look project. This report would have two functions: it certifies the Forward Look practice and it may signal the need for additional actions. This report should be discussed with the Standing Committee and the Member Organisations.

Organising the monitoring is not easy. Ideally, the Forward Looks will have had a broad dissemination and been used by a wide set of science policy bodies. Some recommendations can be easily monitored, such as a suggestion to establish an ERA-Net. More difficult to monitor is the take-up of the report through new instruments, organisational policies etc. which are not mentioned in the reports themselves. This can be done only by ESF's connections in science policy developments through its own policy work, that of the members of the Standing Committees and through ESF Member Organisations.

A suggestion would be an implementation group for each Forward Look report that consists of the chair of the Forward Look committee, one or two members of the Standing Committee and an ESF staff member. They would follow the implementation possibilities identified in the implementation plan and use ESF contacts to facilitate implementation. They would also be responsible for the monitoring report.

Recommendations:

- A Forward Look report is not a scientific report but a text aiming to direct new science policies. As such it needs to be readable and understandable to a broader scientific audience. Its main function is to create a future-oriented perspective on the issue foresighted, which can be taken up within the policy processes. The report will usually contain a set of policy recommendations to convince the readers that policy action is needed *and* possible, but in the implementation phase new policy opportunities may emerge.
- The reputation of ESF Forward Looks will depend on the quality of reports. It is therefore crucial that the ESF develops good quality control procedures for the Forward Looks and the resulting publications.
- Considering the policy function of Forward Looks, the Standing Committees are the proper bodies to be responsible for the quality control at all stages of development.
- Quality control is related to the selection of topics and preparation of the Forward Look activities as well as to outpus of the project (reports).
- Before the publication of a report, the Standing Committee should assess the quality of

the report. This quality control should not be restricted to scientific quality, but also assess issues such as whether the report is understandable for a science policy-oriented audience, is convincing and has clear recommendations. If needed, the Standing Committee can ask for external input for the review.

- After each Forward Look the responsible Standing Committee should discuss possibilities for implementation and monitor over a period of about two years whether and how the report is implemented. After that period the Standing Committee needs to discuss the item again.

3.5. In conclusion

The European research system is changing rapidly. How the research system will be shaped and what the functions and roles of current science policy organisations and instruments will be is uncertain. Discussions about the future of the European Research Council, the role of the EU Framework Programme, discussions on national science policies, on the importance of basic science etc. show that there is a multitude of opinions, interests and changes that together do not create one path to a European Research Area. To speak in foresight terminology: there are many scenarios and each scenario is as likely as the other.

For the ESF these changes imply that its role for its Member Organisations and for the European bodies might become more important than ever. In a highly dynamic policy arena, bodies that connect different levels and can bring together the voices of different actors are crucial for the quality of discussions and policy solutions. One of the new instruments ESF has developed over the last few years is the Forward Look. In this report we have assessed the current experiences with the 10 Forward Looks initiated up to January 2007 and articulated elements of what can become a new foresight practice at the European level.

Whether Forward Looks will indeed become a strong instrument for directing science policies at the European level depends not on reports such as this. It will of course depend on the commitment of the ESF itself to continue its ambition to improve the Forward Looks and learn from earlier experiences. ‘Good practice’ is not a result of following routines, but of continuous reflection on the quality and effects of such routines and the ability to learn. We hope that this report is of some help in these learning processes.

Appendix I

List of ESF Forward Looks (April 2007)

	Starting year	Web links
Current Forward Looks:		
European Computational Science Forum – The Lincei Initiative: from computers to scientific excellence	2006	www.esf.org/lincei
European Food Systems in a Changing World	2006	www.esf.org/food
Higher Education in Europe Beyond 2010: resolving conflicting social and economic expectations (HELF)	2006	www.esf.org/helf
Security – Advancing a Framework for Enquiry (SAFE)*	2007	www.esf.org/safe
RNA World: a new frontier in biomedical research*	2007	www.esf.org/rnaworld
Non-Commercial Clinical Studies*	2007	www.esf.org/nccs
Completed Forward Looks:		
Earth System Science: Global Problems, Global Science – Europe‘s future role in global change research	2001	www.esf.org/globalchange
Cultural Diversity, Collective Identity and Collective Action	2002	www.esf.org/culturaldiversity
Immigration and the Construction of Identities in Contemporary Europe	2002	www.esf.org/identity
Urban Science	2002	www.esf.org/urbanscience
Nanomedicine	2003	www.esf.org/nanomedicine
Systems Biology	2004	www.esf.org/systemsbiology
Nanosciences and the Long Term Evolution of Information Technology (NSIT)	2005	www.esf.org/nsit

*These Forward Looks are not taken into account in the report.

Appendix II

ESF Forward Looks Workshop:
Approaches, Experiences and Perspectives – Brussels, 29-30 January 2007

Programme

Monday 29 January 2007

13:30 – 13:45: Welcoming address
by ESF President **Ian Halliday**

Session 1 **Chair: Ian Halliday, ESF**

13:45 – 14:30: **Barend van der Meulen**, University of Twente (NL)
'Foresight at the Endless Frontier. Looking into an unknown territory and finding it inhabited'

15:00 – 16:30: Four case studies of foresight activities in a basic research context
***Ruth Duncan**,* Cardiff University (UK) – *'Forward Look on Nanomedicine'*
***Ahti Salo**,* Helsinki University of Technology (FI) – *'FinnSight 2015'*
***William Colglazier**,* National Academy of Sciences (NAS), Washington (US) *'Foresight for the Basic Sciences: Its Aims and Limits at the US National Academies'*
***Stefan Michalowski**,* Organisation de coopération et de développement économiques (OECD), Paris (FR)
' "Forward Looks" of the OECD Global Science Forum'

Session 2 **Chair: Michel Dodet, INRA (FR)**

17:00 – 18:30: Panel 1
'Foresight in a basic research context: pitfalls, opportunities and challenges'
***Anne Haila**,* University of Helsinki (FI) -
ESF Forward Look 'Urban Science'
***Peter Raspor**,* University of Ljubljana (SI) – *ESF-COST Forward Look 'Food Systems'*
***Remi Barré**,* Ministry of Research and CNAM University (FR)
Emil Broesterhuizen, Royal Netherlands Academy of Arts *and* Sciences (KNAW) (NL)

Tuesday 30 January 2007

Session 3 **Chair: John Marks, ESF**

9:00 – 10:30: Panel 2
'Foresight report and beyond: impacts of a foresight project'
***Ewa Jedryka**,* European Commission – DG Research, Nano S&T, Brussels (BE)
***Jens-Peter Gaul**,* Deutsche Forschungsgemeinschaft (DFG), Bonn (DE)
***Adrian Curaj**,* National University Research Council, Bucharest (RO)
***Mark Suskin**,* National Science Foundation (NSF), Europe Office (FR)

Session 4

11:00 – 13:00: Conditions for a successful foresight exercise – defining best practice guidelines

11:00 – 11:30: Introduction

11:30 – 12:30: Working groups
1. Quality assurance and credibility of results
   Facilitator: Nina Kancewicz-Hoffman
2. Involving stakeholders and external perspectives
   Facilitator: Barend van der Meulen
3. Impact and the strategic role of foresight
   Facilitator: John Marks

12:30 – 13:00: Reporting by each group

13:00 – 13:30: Closing of the Workshop
by ESF President

Presentations and other Workshop documents are available on the Workshop web page at:
www.esf.org/flookworkshop

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Appendix II

ESF Forward Looks Workshop:
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