A brief review of international experiences in technology foresight

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Abstract

This paper provides a brief overview of international experiences in national technology foresight. It begins with an account of the diffusion of foresight practice between countries and within them, demonstrating its still growing popularity. The paper then describes the different rationales that justify the use of foresight, highlighting their shift away from an original R&D priority-setting focus towards a more process-oriented focus that emphasises dialogue and networking between different actors in national systems of innovation. The methodological approaches used in different countries are then compared, suggesting a possible link between method preferences and political and institutional cultures. In a penultimate section, the paper offers several explanations for the lack of evaluation of foresight. A final section briefly speculates on the continuing need for foresight in future years. The paper draws heavily upon the recently published Handbook of Technology Foresight[1)], where the experiences of national technology foresight exercises conducted in many parts of the world are analysed in considerable detail.

1. Introduction

Basic research, which is considered to be the source of Over the last decade or so, foresight has become an increasingly well-established tool used by policy makers, strategists, and managers around the world. For instance, it has been widely applied at the national level by science ministries and research funding agencies for developing shared long-term visions, for setting research priorities, and for strengthening interactions within research and innovation systems. It is being increasingly utilised in regions to formulate regional science and innovation policies. It is also used in organisations – both public and private – for scanning future threats and opportunities, and for formulating and ‘future-proofing’ long-term strategies.

Our concern in this paper is restricted to national technology foresight activities. The paper begins by describing the diffusion of foresight practice and discusses the different configurations in which it may be embedded in policy making arenas. The diffusion and more extensive use of foresight have been accompanied by an expansion in the rationales of its use, so that much contemporary national foresight activity has a range of purposes, well beyond the early rationale of identifying national priorities. The paper explains these changes and highlights differences between world regions. The following section compares and contrasts methodological preferences between world regions, hypothesising that the choice

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1) See Georghiou et al (2008). For further information, see http://www.e-elgar-business.com/bookentry_main.lasso?id=3977

of some methods reflects political and institutional cultures. Similar hypotheses are put forward regarding the choice of time horizon in foresight exercises. A penultimate section discusses the lack of evaluation of technology foresight, while a final section asks the question, “whither foresight?”

2. The diffusion and ‘sites’ of technology foresight

A chronology of national technology foresight activities highlights its rapid uptake by governments in Western Europe and East Asia during the 1990s (Table 1). More recently, activities have spread to more countries, while most of the original players have instigated new

Table 1 Chronology of selected national foresight exercises

Year	Country	Exercise/Programme	Method(s)
Since 1971	Japan	1st to 4th STA surveys	Delphi
1991	Japan	5th STA survey	Delphi
	USA	Critical Technologies	Others
1992	New Zealand	Public Good Science Fund	Others
	Germany	BMFT, T 21	Others
1993	South Korea	Foresight Exercise	Others
	Germany	Delphi ’93	Delphi
1994	UK	1st TF Programme	Delphi + Others
	France	Technology Delphi	Delphi
1995	France	100 Key Technologies	Others
1996	Japan-Germany	Mini-Delphi	Delphi
	Austria	Delphi Austria	Delphi
	Japan	6th STA survey	Delphi
	Australia	Matching S&T to futures needs	Others
1997	Spain	ANEP	Delphi + Others
	Hungary	TF Programme (TEP)	Delphi + Others
	Netherlands	Technology Radar	Others
	Finland	SITRA Foresight	Others
1998	South Africa	Foresight Exercise	Delphi + Others
	Germany	Delphi ’98	Delphi
	Ireland	Technology Foresight Ireland	Others
	New Zealand	Foresight Exercise	Others
1999	UK	2nd UK Foresight Programme	Others
	Sweden	1st Swedish Foresight	Others
	Spain	OPTI Technology Foresight	Delphi
	South Korea	Korean Technology Delphi	Delphi
	Thailand	ICT Foresight	Delphi + Others
	China	TF of Priority Industries	Delphi + Others
2000	Japan	7th STA Survey	Delphi
	Brazil	Prospectar	Delphi
	Brazil	TFP Brazil	Delphi + Others
	France	2nd 100 Key Technologies	Others
	Portugal	ET2000	Others

Table 1 Chronology of selected national foresight exercises(cont'd)

Year	Country	Exercise/Programme	Method(s)
2001	Venezuela	TFP Venezuela 1st cycle	Delphi + Others
	Chile	TFP Chile	Delphi
	Germany	FUTUR	Others
	Czech Republic	TF Exercise	Others
2002	Turkey	Vision 2023	Delphi + Others
	Colombia	TFP Colombia 1st cycle	Delphi + Others
	UK	3rd UK Foresight Programme	Others
	Cyprus, Estonia, Malta	eForesee	Others
	Denmark	National TF Denmark	Others
	USA	NIH Roadmap USA	Others
2003	China	TF Towards 2020	Delphi + Others
	Greece	Technology Foresight Greece	Others
	Norway	Research Council 2020 studies	Others
	Sweden	2nd Swedish TF	Others
2004	Japan	8th Japanese Programme	Delphi + Others
	South Korea	Korea 2030	Delphi + Others
	Ukraine	Ukranian TF Programme	Delphi + Others
	France	FuturRIS	Others
	France	AGORA	Others
	Venezuela	TFP Venezuela 2ndt cycle	Others
	Russia	Key Technologies	Others
2005	Colombia	TFP Colombia 2nd cycle	Delphi + Others
	Brazil	Brazil 3 Moments	Delphi + Others
	Romania	Romanian S&T Foresight	Delphi + Others
	Finland	Finnsight	Others
	Luxembourg	FNR Foresight	Others
	USA	21st Century Challenges GAO	Others
2006	Finland	SITRA Foresight	Others
	Poland	Poland 2020 – TF Programme	Delphi + Others

Others include: scenarios, panels, roadmapping, critical technologies, etc.
Note: Dates given are point of significant activity rather than formal start or end
Source: Miles et al (2008a)

iterations of activity, though often departing from the formats they used initially. Various hypotheses can be attached to the reasons for this growth, including simple explanations such as diffusion through an 'epidemic' model or fashion, through to more complex analyses about the emergence of new challenges to the role of S&T in a networked economy for which foresight seems to offer some answers (Miles et al, 2008a).

Besides the international diffusion of technology foresight, foresight practices have also spread within countries. For example, in many Western European countries (particularly France, Germany, the UK, the Scandinavian countries, and the Netherlands), it is apparent that such activities are in fact carried out across a wide range of locations and at different levels, including various sites at the national level (e.g. in ministries, research councils, etc.), in sub-national regions, and in organisations (e.g. in national laboratories, large companies, etc.). At the national level, foresight has moved well beyond the boundaries of traditional S&T actors in many countries, and is now regularly carried out by a variety of ministries and agencies across several domains of government (ibid.).

The degree of connectedness between sites and levels of activity is minimal, however, with foresight landscapes typically 'fragmented' with little collaboration between different foresight exercises. This is hardly unexpected while foresight exercises remain largely ad hoc and one-off, as opposed to continuous activities (Saritas, 2006). Under these circumstances, cooperation is likely to be rare and opportunistic, with linkages mostly confined to some recycling of foresight products and to a few instances of methodological learning. By contrast, continuous activities would offer the time and stability for more profound cooperation to develop.

There is significant variety as to where in an organisation / innovation system / policy arena foresight is 'located', i.e. from where it is coordinated and managed, with little discernible pattern according to country/region or foresight rationales (see below). Many arrangements can be found, which tend to be variations of 'in-house', 'semi-detached', and 'outsourced' configurations. The pros and cons of these different arrangements can be framed in terms of an apparent trade-off between a foresight exercise's autonomy and its connectivity to policy arenas. To elaborate, foresight is often viewed as providing a 'space' for the sorts of discourse, analysis and creative visioning that are normally absent in day-to-day policy operations, or even in more long-term strategic planning. This needs to be a 'safe' space, however, if foresight is to be open and adventurous, where the 'unthinkable' can be openly discussed and where discussions are not wholly dominated by current controversies. While this creates a natural need for some disconnection from the 'rough and tumble' of day-to-day policy and decision-making, the challenge has always lain in reconnecting foresight with contemporary policy arenas. This connection has often been achieved via the participation of major stakeholders in the foresight process itself, reflecting an increasingly common belief that foresight is more likely to impact on policy through the agenda-setting and mobilisation of actors – rather than through the dissemination of some new, enlightening codified facts at the end of the process (Miles et al, 2008b).

Another approach to ensuring connectivity to policy arenas has been to embed foresight in existing strategic processes, linking it ever closer to policy and decision-making, and making it (perhaps) more difficult to discern as a distinct and stand-alone activity. Some would argue that such foresight runs a greater risk of being compromised through its embeddedness. This is probably true, but it would be unrealistic to expect all foresight activities to conform to a specific organisational form (ibid.).

Experimentation will no doubt continue, and we are likely to see foresight being used in a wider variety of settings and in combinations with other decision-support tools and policy instruments. In fact, in some STI policy circles, foresight is increasingly viewed as one instrument in a distributed, strategic policy intelligence 'toolbox' that also includes evaluation, technology assessment and various other strategy-making tools. Conceptual work on how such tools might be combined in such a way as to provide policy makers with readily available 'strategic intelligence' has been funded by the European Commission (EC), e.g. the Advanced Science and Technology Policy Planning (ASTPP) network (see Kuhlmann et al., 1999) and the more recent RegStrat project (see Clar et al, 2008). This work suggests there is considerable untapped potential in embedding foresight into practices such as evaluation, although there remains little evidence of many multi-tool approaches being developed for use in policy-making at the current time (Miles et al, 2008b).

3. Rationales for foresight

With the wider adoption of foresight practices in different settings, an expanded and more sophisticated view of its uses has emerged. Accordingly, the rationales deployed by governments when offering justification for their foresight activities have also expanded well beyond the earlier, rather simplistic, rationales that were largely dominated by priority-setting concerns. The latter were driven by fiscal crises within states, as well as by the need to manage the ever-growing 'scientific estate'. It quickly became apparent, however, that many of the issues around science and technology were connected to an 'innovation deficit' – particularly in Europe – and that firms needed to conduct more R&D or at least be better connected to centres of techno-science knowledge production to remain competitive in the longer-term. Foresight therefore assumed a more networking and community-building function, particularly by the mid-1990s, and sought to serve a variety of innovation system actors beyond a sole public R&D funding agency / S&T ministry.

By the late 1990s, a greater emphasis upon the relations of S&T with society also began to emerge, with many governments establishing or strengthening their policies and capabilities in this area. Again, in many places, technology foresight adapted to this new emphasis, particularly in Germany, the UK and Japan (the Nordic countries and the Netherlands already had a strong tradition in this area, which shaped their foresight activities somewhat earlier). To illustrate these changes, Table 2 summarises the shifting rationales of the UK national foresight programme from its inception in 1993 to the present day.

Since societal dialogue rarely substitutes priority-setting, for example, but is instead an additional rationale, much national technology foresight activity today has multiple 'layers' of rationales. A list of some of the common rationales associated with national technology foresight exercises is provided in Box 1. There is a danger, however, of overloading foresight with too many rationales. Well-known cases of this occurring can be found in Germany (see Cuhls, 2008) and the UK (see Keenan and Miles, 2008a), where previous rounds of national foresight activity have collapsed under the weight of multiple expectations.

It should be pointed out that the evolution of rationales described here is largely confined to those countries where foresight has been practiced for some time, particularly in Western Europe. But it would be presumptuous to assume that other parts of the world will follow the same (Western) Eurocentric trajectory, particularly given different political and institutional histories and traditions.

Table 2 Schematic picture of the evolution of UK Foresight

Parameter	Stylised particularities of each cycle		
	Cycle 1 (1993-1998)	Cycle 2 (1999-2001)	Cycle 3 (2002-present)
Main Rationales:	S&T priorities	Business and societal dialogue	Anticipating policy-relevant change and risk
Main Targets:	Initially, scientists and research funding agencies; latterly, also the business community	Wide variety of actors across government, business (including SMEs), the research world, and society	Predominantly government ministries
Coverage:	Mix of sectoral and technological areas spanning most of private sector and some public sector	Mix of sectoral and thematic areas – even wider coverage than the first cycle	Mostly small numbers of focused topic areas of interest to government ministries
Structure:	Standing sectoral panels	Standing sectoral and thematic panels with task forces	Rolling projects
Participants:	Essentially the same across all three cycles, although fewer industry actors are involved in the third cycle		
Methods:	Delphi and workshops used across the Programme, with bespoke methods used by the individual panels	Predominantly scenarios and consultation documents, website for dissemination and interaction	Wide variety of methods, including scenarios, workshops, simulations and gaming, Delphi, etc. used locally in different projects
Outputs:	Panel reports, priorities and recommendations, Delphi results, and a variety of other reports during the implementation phases	Panel and task force reports, many web publications (including scenarios and even videos at one point)	State of science reviews, scenarios, project reports, action plans, academic books, etc.
Reception:	Generally positive, though many argued that the Programme failed to realise its full potential, particularly with regards to reaching the business community	Generally negative, with some panel reports dismissed as dull and uninspiring and the Programme being deemed as unfocused	Very positive, with highly regarded outputs that have been taken up in policy formulation and adaptation

Source: Georghiou et al (2009)

Box 1 Common rationales for national technology foresight

Rationale 1: Directing or prioritising investment in STI
- Informing funding and investment priorities, including direct prioritisation exercises;
- Eliciting the research and innovation agenda within a previously defined field;
- Reorienting the science and innovation system to match national needs, particularly in the case of transition economies;
- Helping to benchmark the national science and innovation system in terms of areas of strength and weakness, and to identify competitive threats and collaborative opportunities;
- Raising the profile of science and innovation in government as means of attracting investment.

Rationale 2: Building new networks and linkages, often around a common vision
- Building networks and strengthening communities around shared problems (especially where work on these problems has been compartmentalised and is lacking a common language);
- Building trust between participants unused to working together;
- Aiding collaboration across administrative and epistemic boundaries;
- Highlighting interdisciplinary opportunities.

Rationale 3: Extending the breadth of knowledge and visions in relation to the future
- Increasing understanding and changing mindsets, especially about future opportunities and challenges;
- Providing anticipatory intelligence to system actors as to the main directions, agents, and rapidity of change;
- Building visions of the future that can help actors recognise more or less desirable paths of development and the choices that help determine these.

Rationale 4: Bringing new actors into the strategic debate
- Increasing the number and involvement of system actors in decision-making, both to access a wider pool of knowledge and to achieve more democratic legitimacy in the policy process;
- Extending the range of types of actor participating in decision-making relating to science, technology and innovation issues.

Rationale 5: Improving policy-making and strategy formation in areas where STI play a significant role
- Informing policy and public debates in these areas;
- Improving policy implementation by enabling informed "buy-in" to decision-making processes.

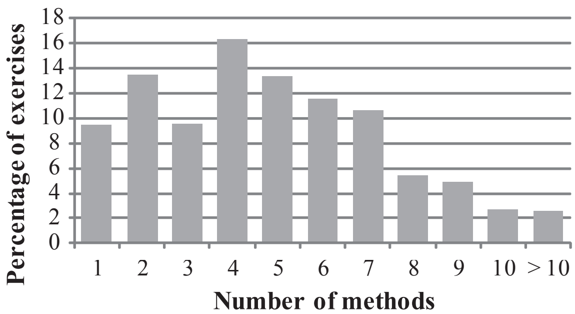
Source: Miles et al (2008a)

4. Methodological approaches

The choice of methods used in foresight is typically informed by a variety of influences, including available resources (particularly time and funding), desired outputs (and outcomes), sponsor preferences, the nature of the domain areas being covered (and existing knowledge of and approaches to understanding future trends and issues in those areas), and target groups (Keenan and Miles, 2008b; Popper, 2008). Coinciding with an expansion in the rationales for foresight is the emergence of more complex exercises in terms of scope and design. Recent mapping of two thousand foresight exercises by the EC-funded European Foresight Monitoring Network (EFMN) shows that, on average, exercises use 5-6 different methods (Figure 1).

As for preferences for individual methods, Table 1 shows there to be a clear family tree in terms of the use of large-scale Delphi surveys which also spills over into the hybrid exercises (those combining Delphi with other methods). Another explicitly-related family tree is that of critical technologies exercises. Among the activities which use other methods (e.g. scenarios, panels and roadmapping), the linkages are more complicated.

Analysis of EFMN foresight mapping data suggests that international learning is somewhat selective. Broadly speaking, the earlier exercises have been the most influential, partly because of their pioneering nature and partly because some of their key participants have become expert in the process of policy instrument transfer itself (Miles et al, 2008a).



Source: EFMN database

Figure 1 Common rationales for national technology foresight: Number of methods used in foresight exercises mapped by the EFMN (percentage; total number of mapped exercises analysed: 886)

It is perhaps for these reasons that large-scale Delphi surveys have been employed by many countries since the mid-1990s (following Japanese, German and UK experiences)[2), even though many other methods could have been used instead and perhaps more effectively.

Figure 2 shows the top ten foresight methods used in six world regions. It indicates that there are 16 different methods featured in the top ten across the six regions. Some methods are ubiquitous across the world, particularly the use of expert panels, scenarios, trend extrapolation, and literature review. Of more interest, however, are those methods that tell us more about differences in foresight 'style' between different parts of the world. The first of these methods is (futures) workshops, which figure prominently in Northwest Europe and North America but are much less prominent in Central and Eastern Europe and Asia (in fact, they are in tenth position in both regions) and are absent from the top ten in Southern Europe and South America. The second method of interest is Delphi, which, in terms of its regional distribution, has an almost opposite profile to that of futures workshops. Thus, Delphi is most commonly used in Southern Europe and South America, closely followed by Eastern Europe and Asia. It is absent from the top ten in Northwest Europe and North America.

To what extent can this apparent pattern of preferences be explained by political and socio-cultural factors specific to different parts of the world? Keenan and Popper (2008) offer a hypothesis, which would require further research to confirm or to refute. In the more established democracies of Northwest Europe and North America, actors more at ease with openly discussing contested futures confront one another in face-to-face forums offered by workshops. By contrast, in newer democracies, or in Japanese society, where there is less tradition of open confrontation, the more anonymous method of Delphi is preferred. Furthermore, Delphi generates a lot of codified output that is more amenable to analysis and assessment than workshop 'talk' and is therefore preferred by states with a 'strong' tradition of orchestrating socio-economic activity from the 'centre'[3).

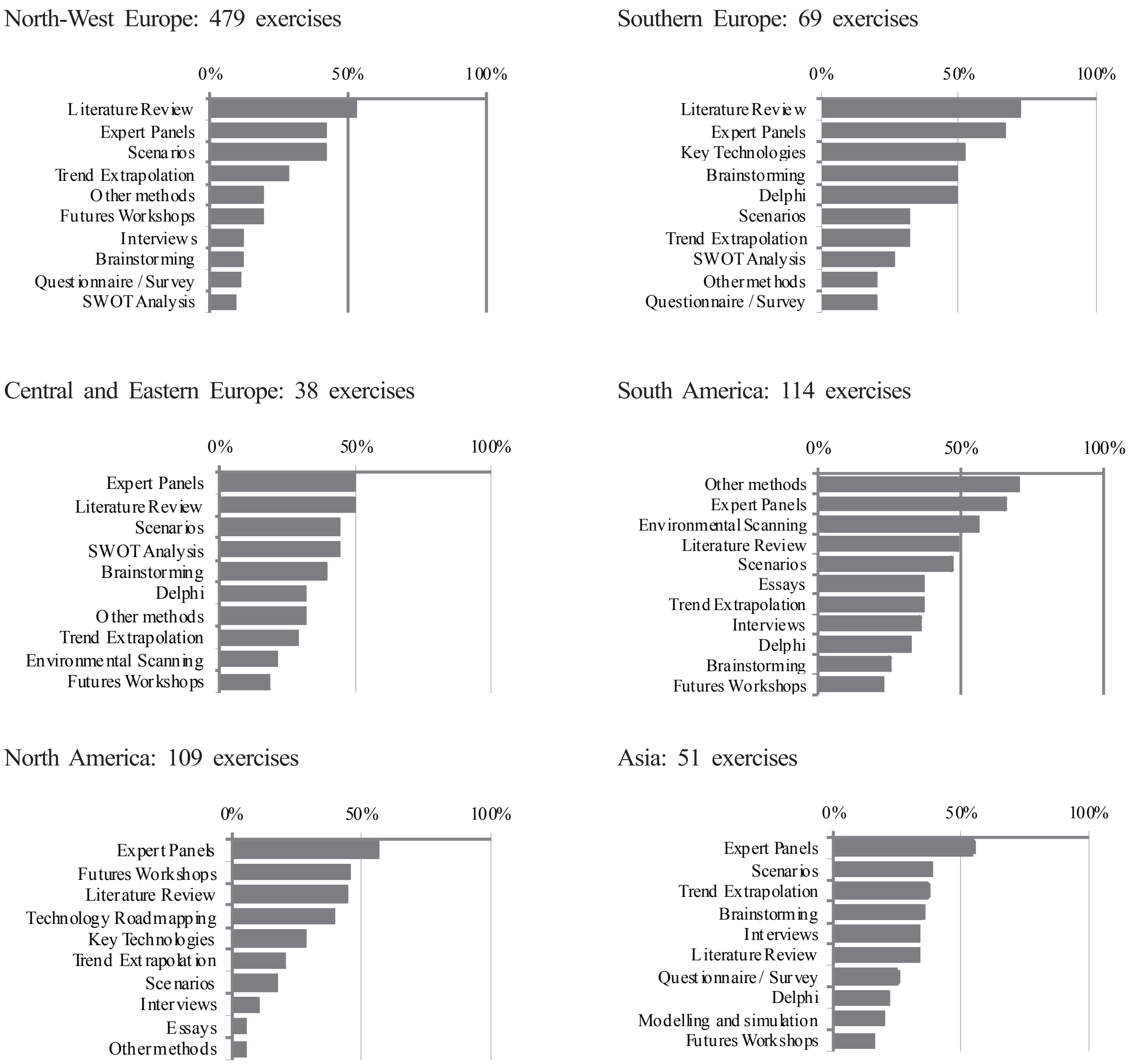
5. Preferred time horizons

Another aspect of foresight with notable variety between different world regions concerns the time horizons that are used. These tend to be heavily dependent upon the domain area being addressed and the information needs of target groups. For example, a foresight exercise focused upon the energy sector might have a time horizon of more than 50 years whereas an exercise focused upon information technologies might look out no further than 10 years.

As Figure 3 shows, the most common time horizon among those exercises mapped by the EFMN lies between 2010 and 2020. As virtually all of the exercises mapped by the EFMN were carried out between 2001 and 2006, it can be assumed that most exercises are looking 10-20 years ahead. The only exceptional region in this regard is Central and Eastern Europe, where shorter 5-10 year time horizons are by far the most common. Around one-

2) The German and UK experiences were in fact earlier imitations of the Japanese experience, with, for example, the first German exercise an almost direct translation of the most recent Japanese survey (see Cuhls, 2008; and Keenan and Miles, 2008a).

3) There are other possible explanations for these patterns of course: for example, the early adopters of foresight, i.e. Northwest Europe and North America, also made more extensive use of methods like Delphi in previous times but have since moved to other approaches. So the regional patterns observed may reflect, at least in part, different points on an adoption curve. Another possible explanation relates to 'measurement bias' in the EFMN database, where a lot of foresight activity mapped for Northwest Europe is relatively small-scale and therefore more likely to favour 'light' methods (e.g. workshops) over 'heavy' methods (e.g. Delphi).

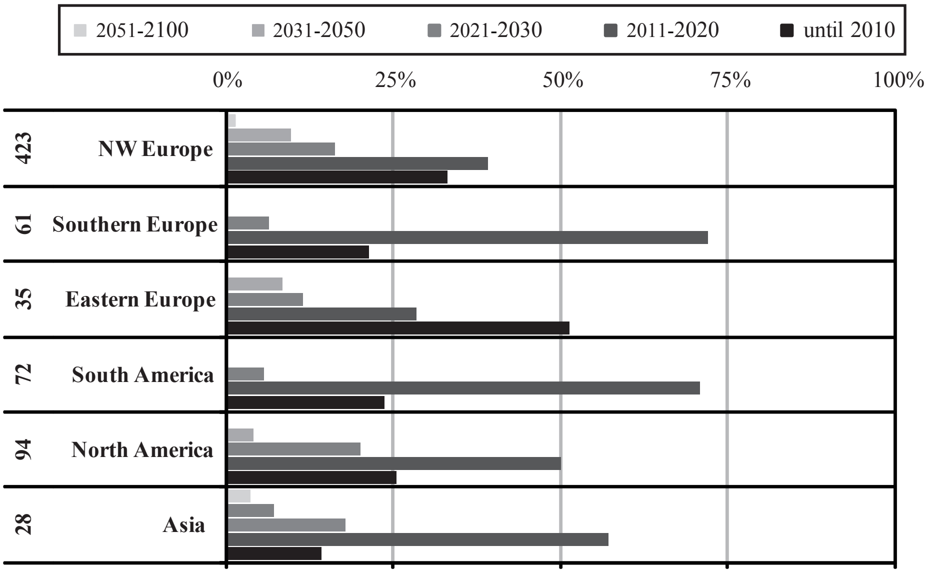


Source: Keenan and Popper (2008)

Figure 2 Top ten methods used in foresight exercises, by world region

third of exercises mapped in North-West Europe, Asia, and North America have time horizons longer than 15 years, whereas less than 10% of exercises in Southern Europe and South America fall into this category. Central and Eastern Europe lies somewhere in between.

How to explain this regional variety? Again, Keenan and Popper (2008) offer a hypothesis: that time horizons are more likely to be shorter in fast-changing societies marked by rapid socio-economic transition than in those where there is more stability and greater certainty around short-term prospects[4]. Of course, alternative hypotheses are possible: for example, it might be that those regions with technological leadership positions will need to adopt longer time horizons given their relevance for advanced S&T development efforts.



Source: Keenan and Popper (2008)

Figure 3 Time horizon of foresight exercises, by world region

6. Assessing the benefits of foresight

An expansion in expectations around technology foresight has outpaced a better understanding of the dynamics of foresight. This conceptualisation 'gap' needs to be bridged to allow systematic evidence to be collected around the impacts of foresight exercises. However, attempts to address this gap, and by extension, to evaluate the impacts of foresight exercises, have been frustrated by several factors (Barré and Keenan, 2008):

- The objectives set for foresight are often wide-ranging and vague, making them problematic starting points for evaluation
- The intangible benefits that are said to accrue from foresight are difficult to assess in themselves
- The complexity of cause–effect relationships, which cannot be handled by the often overly simplistic models used when trying to understand and give meaning to foresight activities and their effects, make evaluation difficult
- The systemic and distributed nature of foresight means that benefits are likely to be dispersed across a landscape of actors and systems making attempts to account for effects resource-intensive
- Many expected impacts of foresight take several years to materialise, and when they do, they are often dependent upon other factors, leading to attribution problems
- There are so many different methodologies and settings for foresight that it is difficult to arrive at standardised evaluation approaches
- The costs associated with a full evaluation of foresight activities tend to be well above the recommended 2-5% of total exercise budgets

Nevertheless, attempts have been made to assess foresight's impacts, particularly at the national level. As Table 3 shows, a variety of approaches have been used, ranging from student studies to full-fledged evaluations (e.g. PREST, 2005). This partly reflects the quite different rationales and approaches associated with foresight exercises, but also the different types of issues that might be covered by an evaluation. For example, foresight can be evaluated at different levels of aggregation: as a policy, a programme or as practice. Each of these levels raises different sets of issues that demand a different evaluation approach.

4) Of course, Asia is perhaps undergoing the most profound and rapid transition of all world regions today, but as the EFMN's Asian sample is dominated by Japanese foresight exercises, this transition is not reflected in the Asian data for time horizon

Table 3 Evaluation of national foresight activities

Country	Evaluation Effort
Austria	Internal assessment of impacts by Science Ministry
Colombia	Panel evaluation 2007/8 addressing process and impact with national & international Validation / Evaluation Committees.
Germany	Delphi 98 evaluation questionnaire; FUTUR evaluated during 2002 and again in 2004
Hungary	Panel evaluation 2003/4 addressing process and impact
Japan	Assessment of realisation of results some 15-20 years after identification in STA forecasts. Also foresight evaluated as a part of broader evaluations of its host institute NISTEP.
Malta, Cyprus and Estonia	“Light” expert evaluation of the eForesee project, examining the achievements of an EU-funded project that linked the foresight activities of these 3 small countries
Netherlands(OCV)	Self-evaluation, PhD study, evaluation by Advisory Council for Science & Technology (AWT)
Sweden	Process (and not the impacts) evaluated continuously by an Evaluation Committee. New evaluation in 2005
United Kingdom	For the first cycle, sub-critical ad hoc studies; some limited external (and independent) scrutiny, e.g. by Parliament, a PhD study, etc. OSI conducted a self-evaluation of the second cycle. External evaluation conducted of the third cycle (PREST, 2005).

Source: Georghiou and Keenan (2008)

In a policy evaluation, issues of rationale for public action are dominant and the interaction of foresight with other policies becomes a topic of focus. In programme evaluation, the objectives of the foresight exercise become a primary focus, mostly in terms of the achievement of objectives but also in terms of their appropriateness, which constitutes a link to policy evaluation. Foresight as practice focuses on the methods and structures used. These may be evaluated both in their own terms and in terms of whether they were fit for purpose. In a full-fledged evaluation, combinations of these levels, albeit with different emphases, are likely to be in evidence (Georghiou and Keenan, 2008).

7. Whither foresight?

The need for foresight, as well as its likely range of applications, is expected to continue to grow. In the field of techno-science alone, there are many newly-emergent frontiers opening up that will require an active shaping if future problems are to be managed. These include issues around environmental degradation, energy supply, various forms of human-enhancement, and the convergence of nanoscience, biotechnology, information technology and cognitive science (NBIC), to name but a few. How foresight will be used to address these, and other ‘grand challenges’, remains to be seen. But they will need to be addressed and foresight practitioners will need to rise to the challenge (Miles et al, 2008b).

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