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Introduction

# New horizons and challenges for future-oriented technology analysis—The 2004 EU–US seminar☆

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The contribution included in this special issue builds on material presented to the first EU–US Scientific Seminar on 'New Technology Foresight, Forecasting and Assessment Methods' that was held in Seville on 13–14 May 2004, organised by the Institute for Prospective Technological Studies (IPTS) of European Commission's Directorate General Joint Research Centre. The starting point and ideas behind the organisation of the Seminar were to learn and consolidate from the recent rejuvenation and growth in future-oriented technology analyses (FTA). In fact, during the recent sharp expansion of FTA, that mainly took place in last two decades, there has been little systematic attention to conceptual development, research on improved methods, methodological choice, or how best to merge empirical/analytical methods with stakeholder engagement processes. In addition, the idea was to analyse possible overlapping fields of practice among technology foresight, forecasting, intelligence, roadmapping, and assessment. The diversity among these disciplines reflects the complexity of demands for FTA relating to differences in scope (geographic scale and time horizon); relationship to decision making, the extent of participation; the purpose of the analysis (awareness raising, envisioning, consensus building, corporate technology planning, etc); the reliability of source information; and so on.

☆ The views expressed in this article are those of the author only and may not in any circumstances be regarded as stating an official position of the European Commission.

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The seminar was organised to encourage cross-fertilization along six key issues of relevance for FTA research:

## 1. Methodological selection

This session focused on experience and guidance on which methods to use for what purpose, when and in what combination with other techniques. One of the main issues introduced was methodology selection and the perennial conflict between the search for methodological perfection and ease of implementation. One of the concepts discussed was that of robustness in the methodologies on offer when the constituency making use of these results views outcomes. To some extent convergence of opinion and broad measures of agreement were voiced that integrating FTA methods with established processes of strategic planning is difficult but very necessary to embed futures analysis into the strategic decision-making process.

The issue related to combination of methods was reviewed and, in particular, using multiple methods in controlled experiment mode. These approaches offered further refinement and support to the development of robustness in spite of added complexities in implementation.

The open discussion examined the role of experts in various methodologies and debated the question of the weight to be given to expert input and who were experts in any case. The discussion also addressed the wider issues of the broadening perspectives that are being introduced to future work beyond technology and its development. There was a concern expressed that the existing guides to methodologies had not moved forward to encompass these developments.

An over arching impression left by this element of the Seminar was that of a rapidly developing and dispersing field of endeavour comfortable with its achievements to date but acutely aware of the danger of losing focus as the demands of ‘clients’ place more and more complexity in the field of application.

## 2. Process management and design

This session concentrated on the three crucial elements of context, content and process and identified that context was a main determining factor in shaping content and process. Trends were appearing in terms of focus of countries at different stages of economic development with those countries with lower development levels favouring a socio-economic focus while those with higher levels of economic development lean towards a techno-economic focus.

There was a strong suggestion that FTA content is increasingly market-driven and more focused on how technology should be used to meet emerging future needs. The longstanding issue of the need for involvement (and engagement) by decision makers in the study were also stressed.

The main proposal in terms of process advanced the view that full use should be made of ICT in enabling data collection and analysis. The process element also highlighted the importance of the management process for foresight studies and the need to adopt a systemic approach to integrating the context, content and process.

## 3. Models and voices

This session concentrated on the combination of expert opinion with qualitative techniques. There was no discussion of data based systems, only judgement based systems. A wide range of

techniques and tools were used in complex combinations and the focus on policy formulation was tight.

One problem, which was highlighted, was the tendency to compensate for difficulty in handling combined techniques by narrowing the scope of the study and consequently narrowing the range of futures considered. On the other hand, a consistent success factor was found in the communication and knowledge sharing elements of studies which added to the value of the policy formulation outcomes.

In addition to a complex combination of techniques, two contributions addressed the broadening of well-established quantitative methods to mesh with qualitative methods. This approach should provide enhancement to models in the future.

The other major discussion focussed on experts, their orientation and the problems associated with their understanding of assumptions used in FTA and how to interpret and combine their diverse opinions and inputs. Political feasibility is an important prerequisite for policy makers' acceptance of FTA conclusions and moulding expert opinions into good conclusions remains an elusive goal.

## 4. Tales from the frontier

The contributions to this session had a fairly common theme in that they focussed on the establishment of databases and the associated data collection, manipulation techniques and related problems and threats. The issue of how to make available the information being created in FTA exercises brought out diverse opinions varying from concerns with intellectual property rights and exploitation of the resources to exponents of open source approaches to such information. Important among the concerns expressed were avoidance of reaching consensus too quickly and constraining the development of emerging technologies, failing to use available techniques to encourage culture change in stakeholder organisations and creating a much greater digital divide by over-restriction of access to available information.

## 5. What's the use?

This session was devoted to the issues of evaluation of FTA and its techniques and processes. The main high-level issues for evaluation were how to reconcile the routinization and standardisation that evaluation encourages with the creativity and 'wild card' nature of many of the ideas implicit in good FTA. Devising acceptable evaluation methods to deal with visionary work in processes is not easy and raises a challenge for the FTA community.

The general consensus in the session was that FTA is a driver and an instrument for social change and as such will require high quality evaluation and at the same time within its own constructs, visions and techniques will challenge current evaluation processes and ideas. Evaluation also serves to highlight the role of FTA as learning processes for stakeholders and thereby encouraging widespread innovation in organisational responses to the challenges of the future.

## 6. Importing ideas

As might be expected of a session dealing with new ideas on FTA there was a wide diversity of suggestions and issues presented. They ranged over linking evolutionary theory with foresight to provide

new ways of framing studies, applying the concepts underlying marketing tools based on human behaviour to foresight design, new brainstorming methods, experience curves, applying foresight to the concept of continuous social transformation with responsibility, voluntary negotiated agreements in major policy areas giving rise to foresight and a revisit to road-mapping and TA and the role and management of experts.

In the discussion it was pointed out that the increasing complexity of the strategic approaches called for a more complex form of foresight. It was suggested that maybe technology foresight could learn something from the past 20–30 years in socio-economic study of science and technology, and especially about issues of substitution, lock-in, path dependency. Lock-ins occur early in technological trajectories, so you have to be able to detect them. The question was also raised as to whether the foresight community itself was locked-in in methodological terms given the age profile of methods.

## 7. This issue

The articles of this issue only partly cover the richness of the papers delivered at the Seminar. The articles were selected from three sessions. One contribution comes from the 'Methodological selection', four articles were presented in 'Tales from the frontier', therefore dealing with new methods of FTA, and other two articles focus on analysis of methods and tools that have been or could be adopted from other fields (i.e. 'Importing ideas' session).

In the first paper Gordon, Glenn and Jakil, describe boundaries and challenges related to methods and approaches to improve the value and utility of FTA. Among the methodological issues that could be tackled to improve the FTA field and start to turn it into a more scientific field, the authors of the papers suggest a number of developments such as a more systematic integration of new technology (especially ICT) to allow interaction and combinations of different techniques to build effectively strategic intelligence. Other developments deal with reducing the domain of unknowable that play an important role when dealing with the future, and enhanced tools that would allow for a better externalisation of uncertainty that could be made more explicit especially for policy makers.

The second paper by Porter illustrates a technique to carry out quick empirical technology analyses based on wide availability of rich science and technology publication and patent abstract databases to better inform technology management. This paper describes, through a case study on solid oxide fuel cells, the value of quick text mining profiles of emerging technologies. One of the main advantages of this technique (i.e. QTIP-Quick Technology Intelligence Processes) is that it allows the conducting of a certain technology analysis within only a few days instead than few months by taking advantage of four factors enabling the QTIP technique: instant database access, analytical software, automated routines, and decision process standardization. The paper discusses the importance of process management for 'tech mining', and how tech mining outcomes could be used for technology management and on how the utility of outcomes can impact the different forms of FTA (i.e. technology foresight, technology assessment, technology forecasting, technology and product roadmapping).

In the paper entitled 'The role of Scanning in Open Intelligent Systems', Patton describes the system in place in SRI Consulting Business Intelligence to scan the environment and detect early signals of change such as discontinuities, inflection points, outliers or disruptive developments. The process is targeted mainly to the private sector and is a useful service for companies to monitor the complex business environment and provide information to allow adaptation of strategies. The article describes the

process on how the system operates, the players involved, and the type of products the system generates, including some examples.

The two following articles, focusing on Technology Assessment (TA) and, using as case study nanotechnology, stress the pressure that new technology developments are posing to the field of TA. Therefore, in order to continue to be effective, TA must in some cases revisit its approaches and toolbox of techniques to ensure that outcomes can be taken up in the decision-making process. The first contribution from van Merkerk and Van Lente, describes a methodology to map and understand the dynamics of emerging technologies. The article introduces the importance of understanding and tracing the role of 'irreversibilities' of technological changes (i.e. expectations that guide the research activities of scientists and firms, and the process of agenda building). A three-level framework on the case of nanotubes is presented to analyse and visualise the dynamics in three interrelated context: research groups, technological field, and society.

The second contribution by Fleischer et al., argues that TA of emerging (and enabling) technologies requires the introduction and use of new methods. The article illustrates the use of roadmapping as a tool for TA contributions to the sustainability assessment of emerging technologies.

The paper by Boyack proposes the use of information and visualisation techniques as supporting tools for FTA especially to assess technological development in the short term.

The last paper by Dezevas presents the state-of-the-art and new approaches in the evolutionary theory of technological change as a tool for FTA. It discusses the questions and validity of the analogy between technological evolution and biological evolution, but considering the 'new perspective' of the impact of new capabilities that are provided by the Information Technologies and the convergence of information and molecular technologies. They stimulate the development of new insights on simulation methods and evolutionary programming. The paper shows that concepts applied to biological evolution are applicable, through useful metaphors, to economics and technology assessment.