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Introduction to a special section: Impacts and implications of future-oriented technology analysis for policy and decision-making

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Experiences of recent years place a premium, for governments and individuals, on being able to discern the possible shape of the future: what is likely to influence it, and what can be done to prepare for it. This special section is based on selected papers from the Third International Seville Seminar on Future-Oriented Technology Analysis, held 16–17 October 2008 at Seville, Spain, which addressed the challenge of increasing the impact of future-oriented technology analysis on policy and decision-making.

THE RECENT ONSET OF CRISES AND challenges ranging from climate change, financial and economic downturns, to security threats highlight a rising need to incorporate more forward-looking approaches into the decision-making processes of public and private organisations and stakeholders all around the world. However, there is no clear evidence yet that this dynamic context has led to a significant increase in the use of such approaches. The contributors to this special section of *Science and Public Policy* believe that forward-looking approaches need further tailoring in order to suit better the needs of decision-makers and their changing environment, and that there is an urgent need to inform decision-makers of the potential value of future-oriented technology analysis (FTA) approaches (Johnston and Cagnin, 2010).

Therefore, the aim of this special section is to refine FTA methodologies in order to increase their impact in policy-making. With this purpose in mind, this introductory paper sets out the general framework for approaching this topic. First, it suggests a specific definition of FTA, identifying its different possible roles for policy and decision-making. It then formulates a set of general recommendations with the intention of improving the policy impact of FTA. Last but not least, it introduces the different contributions to this special section one by one, highlighting the way in which these different papers propose to redefine FTA in specific policy-making contexts.

The papers that form this special section were selected from those presented at the Third International Seville Conference on Future-Oriented Technology Analysis held 16–17 October 2008 in Seville, Spain. This biannual conference provides a common platform for user communities of foresight, forecasting and technology assessment to reflect on these challenges. The third conference focused on the impact that FTA can have on policy and decision-making and its implications.

Defining FTA and its impact on policy and decision-making

FTA is a generic label that groups a number of forward-looking methodologies used to better

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anticipate and shape future technological developments, mainly, technology foresight, technology forecasting and technology assessment. The FTA label brings together a set of widely differing techniques, and several scholars have proposed different classifications of these techniques. The different dimensions used to classify these different FTA techniques include: the type of technique (qualitative versus (semi) quantitative), the type of approach (exploratory versus normative), or the type of knowledge source (expertise-interaction/creativity-evidence) (Eerola and Miles, 2008; Popper, 2008; Saritas, 2006). Scapolo and Porter (2008) propose 13 families grouping more than 50 FTA methods, building on a typology proposed during the first FTA conference in Seville by the Technology Future Analysis Methods Working Group (see Table 1).

Keenan and Popper (2007) defined six principles to distinguish FTA from other policy-support techniques: future-orientation, participation, evidence-based, multidisciplinarity, coordinated mobilisation of people and resources, and action orientation. Not all techniques described in the classifications mentioned comply to the same extent with all six principles. For example, many quantitative techniques usually have a small participatory base, while purely qualitative approaches tend to have a weaker evidence base. The principles proposed by Keenan and Popper can be used as strict selection criteria to define whether or not a methodology belongs under the FTA umbrella. But they could also be considered as qualitative criteria, measuring the degree to which a technique can be considered to be part of the FTA toolbox. Its average score can then be defined as its FTA-score.

Table 2 shows examples of modelling and horizon scanning. Horizon scanning is a rather new FTA tool, as further described below, and could become a 14th family of methods in Scapolo and Porter's classification. The scores on the six principles can also differ for the same tool, depending on the context in which it is applied, as is shown in the examples in Table 2. Some authors recommend the use of specific combinations of tools and approaches in order to build more robust methodologies (Rader and Porter, 2008). If combinations of tools and approaches are well selected, they can result in a higher overall FTA score.

Refining FTA methodologies with the aim to improve their impact on policy and decision-making requires a clear definition of what this impact can be. At first sight, the degree of action-orientation of any FTA is likely to determine the degree of its impact on policy and decision-making. However, other characteristics of FTA can influence its impact, depending on the functions of FTA in a particular context.

Table 1. Future-oriented technology analysis methods (Scapolo and Porter, 2008)

Families of methods	Sample methods
Creativity approaches	Theory of Inventive Problem Solving (TRIZ), future workshops, visioning
Monitoring and intelligence	Technology watch, tech mining (Porter and Cunningham, 2005), web mining (van de Lei and Cunningham, 2006)
Descriptive	Bibliometrics, impact checklists, state of the future index, multiple perspectives assessment
Matrices	Analogies, morphological analysis, cross-impact analyses
Statistical analyses	Risk analysis, correlations
Trend analyses	Growth curve modelling, leading indicators, envelope curves, long wave models
Expert opinion	Survey, Delphi, focus groups, participatory approaches
Modelling and simulation	Innovations systems descriptions, complex adaptive systems modelling, chaotic regimes modelling, technology diffusion or substitution analyses, input–output modelling, agent-based modelling
Logical/causal analyses	Requirements analysis, institutional analyses, stakeholder analyses, social impact assessment, mitigation strategising, sustainability analyses, action analyses (policy assessment), relevance trees, futures wheel
Roadmapping	Backcasting, technology/product roadmapping, science mapping, multipath mapping (Robinson and Propp, 2006)
Scenarios	Scenario management, quantitatively based scenarios, different emphases and dark scenarios (Punie *et al*., 2006), science theatres, video (Steyaert *et al*., 2006; Decker and Ladikas, 2004)
Valuing/decision-aiding/economic analyses	Cost-benefit analysis, SWOT (strengths, weaknesses, opportunities, threats) and scorecard analyses (Sripaipan, 2006), analytical hierarchy process, data envelopment analysis, multicriteria decision analyses
Combinations	Scenario-simulation (gaming), trend impact analysis

Table 2. FTA scores for modelling and horizon scanning

FTA score for modelling			FTA score for horizon scanning		
Characteristic	**Score**	**Comment**	**Characteristic**	**Score**	**Comment**
Future orientation	***		Future orientation	***	
Participation	*(**)	* Consultation of experts for certain parameters ** Validation of modelling output in a workshop *** Validation through wide consultation	Participation	**(*)	Depends on size of community involved
Evidence-based	***		Evidence-based	*	
Multidisciplinarity	***		Multidisciplinarity	***	
Coordinated mobilisation of people and resources	*		Coordinated mobilisation of people and resources	*	
Action oriented	*		Action oriented	*	
Total	**		Total	**	

Six functions of FTA for policy-making are:

- informing policy;
- facilitating policy implementation;
- embedding participation in policy-making;
- supporting policy definition;
- reconfiguring the policy system; and
- having a symbolic function.

These functions were an important outcome of the Second International Seville Seminar on Future-Oriented Technology Analysis held in 2006. The extent to which one or more of these functions have been fulfilled can be considered as the degree of impact on policy-making.

Refining FTA for more impact on policy and decision-making

With a view to improving the impact of FTA on policy-making and thus on the extent to which FTA succeeds in fulfilling the above-mentioned functions, the Third International Seville Conference on Future-Oriented Technology Analysis arrived at various general recommendations for increasing the impacts of FTA activities in policy-making, such as:

- *Do not think of impacts at the end*. Rather, start with the impacts and their larger implications early enough to engage clients and stakeholders in the strategic question of how FTA can improve both their preparedness and ability to move fast when the signals or threats are there.
- *Make sure the client's policy commitments as well as communication resources are well provided for and planned early in the process*. This is not something to be discovered along the way.
- *Establish explicit expectations and measures to assess performance*. Understand the depth of engagement and the learning process that can be possible.
- *Stay connected to leadership*. This can be done tacitly if necessary but should be done as formally as possible when the opportunity is there.
- *Keep the message simple and keep improving it through rigorous pursuit of impact*. Dedication to quality, insights, effective communications and innovation are also important.
- *Translate and transfer FTA outputs into policy and decision outcomes*. What has been accepted by many FTA practitioners as 'post-foresight', and hence not their responsibility, should now be recognised as an integral part of the FTA process.

Apart from these general recommendations, individual papers presented at the conference proposed a wide variety of methodological approaches that could improve policy impact. The papers selected for this special section of *Science and Public Policy* explore how both public and private organisations are able to deal with the issue of uncertainty by incorporating forward-looking methodologies into their decision-making processes. This renders decision-making smarter and more capable of tackling expected future challenges. Although the applications described in the papers are very different, their methodologies contribute to the convergence of a variety of forward-looking tools. Furthermore, by exploring new mixes of FTA tools they contribute to the creation of FTA techniques that are more adaptive to clients' needs and to context characteristics. Last but not least, this special section also contributes to the identification of key success factors in the application of these techniques.

The paper by van Rij looks at horizon scanning from an adaptive foresight angle, by combining the experiences and data of three governmental horizon scans in the UK, the Netherlands and Denmark, as developed in the ERA-Net ForSociety Project. The paper highlights the range of purposes this tool can serve, by challenging policy-makers to look at uncertainties and unexpected futures, in order to develop more resilient policies towards sustainability. The analysis leads to specific process recommendations for national horizon scannings related to how data are gathered, analysed, synthesised and used. In general, the paper also recommends connecting horizon scans to more focused foresight activities. It concludes with a proposal to build a European network for using joint scan data and exchanging best practices and methodologies.

Adaptive foresight is applied by Abadie *et al*. to the highly uncertain environment of the European creative content industries as part of the European Perspectives on the Information Society project. The project used a tailored combination of methods in order to respond to clients' needs and the particular characteristics of a fast changing sector. The paper addresses a range of emerging issues and their possible impacts throughout all stages of the process in order to improve our understanding of possible futures. The limits of current methodologies and the need for further methodology development in this area are highlighted, due to the fact that the project did not lead to direct policy measures.

The paper by Calof and Smith contributes to the definition of successful foresight studies by identifying a set of critical success factors for government-led foresight, beyond selecting an appropriate budget and methodology. They conclude that foresight programmes need a clearly identified client, a clear link with today's policy agenda and propose some research questions to further analyse these critical success factors. Their analysis is based on the results of two surveys of selected international foresight practitioners and leading foresight organisations, conducted by Canada's Office of the National Science Advisor and the Telfer School of Management at the University of Ottawa, and supported by Agriculture Canada and the Smart Economy Project.

Damrongchai *et al*. describe an appropriate mix of foresight methods that was applied in a research project of the Asia-Pacific Economic Cooperation aiming to better understand the complexity of emerging infectious diseases (EID). The methods combined bibliometric analysis, an online survey and a scenario-building in order to better understand the factors involved in the initiation and spread of emerging diseases. The scenarios revealed an EID lifecycle model, which helps to understand how technology can be used to combat EID at every stage of their lifecycle. The project also created a new network of scientific and technological experts in the area of biosecurity, providing an opportunity for further cooperation in this area.

De Moor *et al*. develop a novel approach for incorporating more user-driven innovation strategies in companies' product development processes using 'living lab' research. They describe how users can be involved in the innovation process in a sustained and effective way, and their insights can be translated into technical requirements. The authors describe how user involvement can be applied during three different research stages in the innovation process, using future mobile applications as a case-study. The analysis is based on the results of the Research on Mobile Applications and Services project, a consortium of industry partners and the Interdisciplinary Institute for Broadband Technology founded by the Flemish government. The methodological framework proposed in this paper is relevant for the development of policies aiming to match technological innovations better to societal needs.

References

Decker, M and M Ladikas (eds) 2004. *Bridges between Science, Society and Policy. Technology Assessment: Methods and Impacts*. Springer: Berlin, Heidelberg, New York.

Eerola, A and I Miles 2008. Methods and tools contributing to FTA. Paper presented at *Third International Seville Conference on Future-Oriented Technology Analysis*, held 16–17 October 2008, Seville, Spain.

Johnston, R and C Cagnin 2010. The influence of future-oriented technology analysis: addressing the Cassandra challenge. *Futures* (in press).

Keenan, R and R Popper (eds.) 2007. *Guide to Research Infrastructures Foresight*. Brussels: European Commission.

Popper, R 2008. Foresight methodology. In *The Handbook of Technology Foresight: Concepts and Practices*, L Georghiou, J C Harper, M Keenan, I Miles and R Popper (eds.), pp 44–88. Cheltenham, UK and Northampton, MA: Edward Elgar.

Porter, A L and S W Cunningham 2005. *Tech Mining: Exploiting New Technologies for Competitive Advantage.* New York: Wiley.

Punie, Y, I Maghiros and S Delaitre 2006. Dark scenarios as a constructive tool for future-oriented technology analysis: safeguards in a world of ambient intelligence (SWAMI). Paper presented at the *Second International Seville Seminar on Future-Oriented Technology Analysis*, held 28–29 September 2006, Seville, Spain.

Rader, M and A Porter 2008. Fitting future-oriented analysis methods to study types. In *Future-Oriented Technology Analysis: Strategic Intelligence for an Innovative Economy*, C Cagnin, M Keenan, R Johnson, F Scapolo and R Barré (eds.). Berlin and Heidelberg: Springer Verlag.

Saritas, O 2006. Systems thinking for foresight, PhD thesis. PREST, Manchester Business School, University of Manchester.

Scapolo, F and A L Porter 2008. New methodological developments in FTA. In *Future-Oriented Technology Analysis: Strategic Intelligence for an Innovative Economy*, C Cagnin, M Keenan, R Johnson, F Scapolo and R Barré (eds.). Berlin and Heidelberg: Springer Verlag.

Sripaipan, C 2006. Foresight in a non-profit organisation: a case of the Technology Promotion Association (Thailand–Japan). Paper presented at the *Second International Seville Seminar on Future-Oriented Technology Analysis*, held 28–29 September 2006, Seville, Spain.

Steyaert, S, S Eggermont and H Vandebosch 2006. Towards the desired future of the elderly and ICT: policy recommendations based on a dialogue with senior citizens. Paper presented at the *Second International Seville Seminar on Future-Oriented Technology Analysis*, held 28–29 September, Seville, Spain.

Van de Lei, T E and S W Cunningham 2006. Use of the internet for future-oriented technology analysis. Paper presented at the *Second International Seville Seminar on Future-Oriented Technology Analysis*, held 28–29 September 2006, Seville, Spain.