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Introduction: Future-oriented technology analysis — Impacts and implications for policy and decision making

The unfolding acceleration of global innovation is expected to become the hallmark of the first half of the 21st century. When preparing ourselves, our institutions and our networks for this phenomenon, our inquisitive intellects and our social networks are both asking some important questions: *what are the critical new tools, where are the cutting edge learning domains and which technologies are advancing the new systems, structures and capabilities that will take us forward to 2020, 2035 and 2050?*

This special issue of TFSC presents a provocative alignment of papers designed to begin the probing of these fundamental questions about the future and future-oriented technology analysis (FTA). FTA provides a common umbrella for the foresight, forecasting and technology assessment communities. These closely related communities play an important role in guiding policy and decision making to anticipate and shape future developments.

The challenge of joining forces to develop more robust future-oriented support to decision making has been addressed in the series of "International Seville FTA Conference" organized by the Institute of Prospective Technological Studies, one of the Joint Research Centers of the European Commission. Building on the success of the 2004 and 2006 events, the third edition of the Conference in October 2008, *Future-Oriented Technology Analysis (FTA): Impacts and implications for policy and decision making* [1], enabled FTA experts, practitioners, and policy and decision makers to share their ideas and knowledge in order to make FTA more policy relevant.

The rising importance of FTA is reflected in the interest for the Third International Seville FTA Conference. In total, 180 participants attended the Conference, representing/covering all continents. Out of the 166 abstracts that were submitted (50 more than in 2006), the Conference Scientific Committee selected 56 papers in order to build a comprehensive Conference program. The Conference program covered both FTA methodological aspects and application of FTA to policy fields, such as, research and innovation, security and sustainability. The best papers presented in this conference are published in four different scientific journals of which this special issue for *Technological Forecasting and Social Change* consists of the selected papers with particular emphasis on methodological aspects of FTA, thus following the example of the first special issue from the previous edition of the Conference [2].

This issue offers the reader a unique opportunity to travel with the editors on a journey of discovery where new approaches to the development of policies for advancing societal innovation are encountered and revealed. The selection of papers provides the practitioners of future-oriented technology analysis (FTA), innovation policy development and others inclined toward the provocation of innovation an opportunity to learn some new approaches as well as to reflect further upon some familiar tools — such as risk assessment being re-profiled within the new context of FTA. In this way the issue also contributes to an evolving tool bag of diverse and enhanced tools for societally useful global innovation.

The papers and technical notes assembled from the 2008 FTA Conference were carefully selected and further nurtured to bring out three key themes:

- FTA is clearly moving ahead to *explore, adopt and engage novel approaches* that will address innovation challenges and change the outlook of many policy makers;
- FTA still remains a *somewhat ambiguous alignment of diverse tools, disciplines and intellectual traditions and paradigms* — and this we believe is consistent with the dynamism of transition to a knowledge-based economy;
- FTA really has *begun to engage and provoke the traditional complacency of policy makers* who tend to treat technology as an externality, who have not as yet widely embraced the predictive power of networks and who seem uncomfortable with the emerging complexity of innovation systems as the key target or "client" for adaptive policies and new approaches.

The full array of papers here is quite revealing.

Of all the papers and a technical note included in this Special Edition, probably the most challenging and innovative for policy makers and FTA process designers is Scott Cunningham's *Analysis for Radical Innovation*. Not only does his paper clearly posit the

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new power of IT and network analytical approaches, but it also directly aims its messages at policy makers responsible for designing more effective strategies for the deployment of public funds for R&D and those responsible for forecasting where and how to do this — no small task indeed!

The essence of Cunningham's model is that the application of hierarchical random graphs of technology characteristics to questions as complex as: *what will be the next internet innovations?* enables a probability model to be constructed that anticipates novel combinations of technologies. Using this model he identified a range of technology changes associated with new standards for accessible internet applications within 100 days of their emergence and without prior reference to the individual technology morphologies–pathways progression. Imagining the prospects if this technique can be more widely developed conjures up exciting possibilities for the anticipation of future innovation system developments.

Complementing Cunningham are several other authors we have included because they are also concerned with the application of novel and adapted FTA tools and approaches.

The excellent paper of Störmer et al., *The Exploratory Analysis of Trade-Offs in Strategic Planning: Lessons from Regional Infrastructure Foresight,* deals with a foresight exercise in connection with strategic infrastructure planning. They argue that foresight allows addressing trade-offs related to context uncertainties, value conflicts and sustainability deficits in a structured way. The paper introduces a specific procedural proposal and illustrates its potential virtues through an application to urban water management planning in a Swiss region.

Koivisto et al. examine how traditions of risk assessment are being adapted to the new more agile and greater uncertainties context of FTA. Their paper: *Integrating Future-oriented Technology Analysis and Risk Assessment (RA) Methodologies* provides a clear example of where an older discipline meets a new one and there are lessons for both in the potential integration. Creating a new process design and foresight capacity that utilizes the strengths of and interplay between FTA and RA approaches is considered a necessity at VTT Technical Research Centre of Finland for being truly innovative while also managing the risks effectively. We the editors believe this is a positive development as it signifies the potential of opening up a fruitful dialogue between the relatively young, broad-scope FTA community and the more established, traditionally focused RA community.

Loikkanen et al., another Finnish team, bring this novel focus on tools further into the interface with policy approaches in their timely paper on the *Role of Technology Barometer in Assessing Past and Future Development of National Innovation System.* The paper makes a convincing case for how one needs new tools to enable effective international positioning for comparative understanding about national innovation ability and performance. In their own words: “world-wide competition is increasingly about the attractiveness of innovation systems” and thus the capacity to know one's own technological position relative to others represents a new FTA capability with real world predictive performance capacity. Relying upon regular inputs of strategic technology indicators across a range of key competitive indices, and complementing these with information from future-oriented stakeholder surveys, the Technology Barometer can be regarded as a new tool for managing strategic investments in R&D, as well as in other areas such as new skills acquisition and patents management etc. The existence of the Technology Barometer is itself a provocative approach to innovation policy futures.

From Germany, we have Cuhls et al.'s account of *The BMBF Foresight Process*. This well designed process breaks new ground in being explicitly concerned with enabling foresight as a *sustainability asset* for Germany's status as a R&D-innovation leader with specific elements also aimed at four innovative targets: *new R&D domains; cross-cutting opportunities; new fields for strategic partnerships; and priorities for innovation policy.* As well, the interplay between foresight and policy is further defined and elaborated, wherein foresight engages policy-making on six levels (informing; facilitating implementation; embedding participation; supporting new policy definitions; reconfiguring policy structures and as a dynamic process, symbolizing policy evolution-change. In many respects the BMBF foresight demonstrates how in practice many of the new approaches are actively engaging a changing view of policy for the knowledge economy.

Volkery and Ribeiro address in their paper, *Scenario planning in public policy: understanding use, impacts and the role of institutional context factors*, the effectiveness of scenario planning in public policy-making. Scenario planning still is often executed in a rather ad-hoc and isolated manner and is mostly geared towards indirect decision support such as agenda-setting and issue framing. The authors analyze the role of scenario planning to prepare public policy-making for the uncertainties and surprises of future developments and better manage complex decisions involving conflicting societal interests.

The paper by Loveridge and Saritas: *Reducing the Democratic Deficit in International Foresight Programmes: A Case for Critical Systems Thinking in Nanotechnology*; examines how vitally important the foresight objective of *inclusiveness* in the embracement of diverse stakeholders is for the credibility of an innovation process. Using contemporary examples associated with the challenges of nanotechnology, they develop the case for ensuring that foresight offers a democratic rather than just a technocratic input to the future and to the policy processes which govern the societal choices that will be required. In their paradigm – a *systemic* one– foresight is a critical way for institutions to examine and advance technology in ways that are *responsive to society's needs* and concerns through the definition of problems and boundaries that must be respected.

Douglas Robinson presents in his paper, *Co-evolutionary Scenarios: An application to prospecting futures of the responsible development of nanotechnology*, a research project exploring potential co-evolutions of nanotechnology and governance arrangements. This involved the inclusion of pre-engagement analysis of potential co-evolutions in the form of scenarios into interactive workshop activities, with the aim of enabling multi-stakeholder anticipation of the complexities of co-evolution.

In addition to the key papers, the technical note of Greg Tegart on *Energy and nanotechnologies: Priority areas for Australia's future* features an excellent case example of the importance and learning being experienced from the application of novel FTA methodologies to explore the possibilities offered by the use of nanotechnologies to contribute to new and improved approaches to energy conversion, storage and distribution in Australia.

We conclude with the observation of Scott Cunningham when he presented his paper *Analysis for Radical Design* to the FTA Conference: "Changes are multitudinous. Therefore new techniques are needed for analyzing technology architecture". This implies a renewed dedication to alternative exploratory modeling, robustness analysis and many of the other similar tools referenced below in the papers and a technical note.

To conclude this special issue we welcome the column "From My Perspective" of the Founder and Editor-in-Chief of this journal and one of the key participants of the FTA 2008 Seville Conference, Professor Harold A. Linstone. He has written a fresh and thought-provoking analysis on Wall Street — "A 21st Century Crisis: Relearning Some Systems Lessons".

The editors heartily agree and so apparently do the authors in this Special Edition. FTA evokes the power and appeal of hopeful, sustainable imaginative futures that can enable our species to apply its intuitive ingenuity to face the challenges of today and those anticipated over the horizon: when FTA enables more robust policy, things can improve.

References

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Totti Könnölä is a research fellow at the Institute for Prospective Technological Studies of the Joint Research Centre in the European Commission. He is also an adjunct professor of operations and technology management at the IE Business School. He has coordinated and supported many strategic decision-making processes to align future R&D priorities and innovation strategies with sustainability goals. He holds a Dr. Tech. and a Lic. Tech. in systems analysis from the Helsinki University of Technology and MSc in environmental economics from the University of Helsinki.

Jack E. Smith is Senior Advisor, Foresight and Innovation Strategy, Defence R&D Canada, and Chair of the Foresight Synergy Network of Canada. Prior to joining DRDC, he was Director of S&T Foresight for the Office of the National Science Advisor to the Prime Minister of Canada and Leader of the Office of Technology Foresight for the National Research Council of Canada. He holds a MSc from Cornell University in Design and Environmental Analysis, and has over 30 years of federal government service in Canada.

Annele Eerola is a Senior Research Scientist of the knowledge center 'Organisations, Networks and Innovation Systems' at VTT Technical Research Centre of Finland. She was the leader of the VTT Technology Foresight and Technology Assessment in 1999–2008, being also the Deputy Technology Manager of the knowledge center since 2007. She holds a PhD from the Helsinki Swedish School of Economics and Business Administration. Her Lic. Tech. and M.Sc. degrees are from Helsinki University of Technology.

Totti Könnölä[1]
Institute for Prospective Technological Studies (IPTS), JRC - European Commission, Edificio Expo, C/ Inca Garcilaso, 3, E-41092 Seville, Spain
Corresponding author.
E-mail address: totti.konnola@ec.europa.eu.

Jack Smith
Defence RD, Ottawa, Canada

Annele Eerola
VTT Technical Research Centre of Finland, Espoo, Finland

[1] The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.