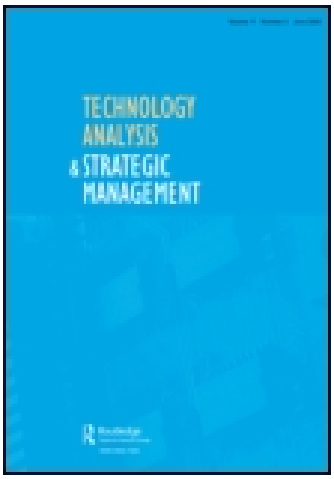

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Preparing for grand challenges: the role of future-oriented technology analysis in anticipating and shaping structural and systemic changes

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EDITORIAL

Preparing for grand challenges: the role of future-oriented technology analysis in anticipating and shaping structural and systemic changes

A series of conferences on future-oriented technology analysis (FTA) has been organised by the Institute for Prospective Technological Studies of the European Commission's Joint Research Centre over the past years. These unique conferences have brought together practitioners from three different communities of foresight, forecasting and technology assessment. The fourth edition (2011) of the International Seville Conference on Future-Oriented Technology Analysis (FTA) focused its attention on processes of transformative change in response to Grand Societal Challenges, and both the need and the potential of FTA to anticipate and shape structural and systemic transformations.

Although earlier conferences had focused in a rather self-reflexive manner on future perspectives for FTA (2004) and the impact of FTA on decision-making (2006, 2008), this last edition was responding timely to the growing demand for forward-looking intelligence in times of crisis and uncertainty, by proposing FTA as a key instrument to help prepare for and tackle Grand Challenges. This problem-oriented approach may have been one of the reasons for a further increase in the number of submitted abstracts and participants. But can FTA really be of help to avoid failure? Or to turn potential threats into opportunities? When launching the call for papers, the FTA Conference Scientific Committee took the stance that

> FTA has a potentially useful role to play in exploring future developments of complex societal systems and in defining effective policy actions, by way of:
> - improving the quality and robustness of anticipatory intelligence and preparedness for disruptive events through the use of systematic approaches and the development of shared insights and perceptions;
> - creating spaces for an effective dialogue between key players in different policy domains;
> - vision-building and consensus-building for engineering major processes of transformation;
> - shaping and defining research and innovation agendas (2011 FTA Conference Scientific Committee).[1]

An even more basic question raised during the conference relates to what the often proclaimed Grand Challenges really are and what we exactly have to prepare for. This topic was taken up by Harold Linstone in his keynote speech, who argued that the industrial era of the past and today's

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information era will be followed by a molecular era, driven by the confluence of nanotechnology, biotechnology and materials science (Linstone 2011a, 2011b). It is these fundamental changes that give rise to the main challenges of today's world. His position may differ in many regards from the views expressed in recent political discourses, which see the main challenges as being rooted in societal rather than scientific-technological developments. Linstone points to the dynamic, complex and adaptive nature of the systems we are dealing with today, as well as to the chaotic phases through which these systems may pass, when moving to the molecular era, thus limiting the possibilities of forecasting. He continued that if we want to bring the systems approach closer to the real world, the organisational and the individual perspectives would become essential, and would need to complement the technological perspective that has traditionally dominated FTA.[2]

It is against the background of such transformative changes that this special issue looks at the fundamental possibilities and limitations of applying FTA to cope with the challenges ahead, and at novel FTA approaches to push the frontier of what can be done to better address them. This approach is in line with a claim made by another keynote speaker, Richard Hames from the Asian Foresight Institute (AFI), who identified four crises of civilisation: a crisis of consciousness, of behaviours, of cultures and of systems (Hames 2011a). In response to these crises, he saw a need for new forms of dialogue at different levels, in order to deconstruct assumptions from the vested world view and construct new assumptions for an alternative world view. He concluded that there is a lack of critical thinking at epistemological and ontological levels in particular, and too much of a business-as-usual mentality (Hames 2011b). He, therefore, suggested making more use of approaches that allow for exploring such levels of thinking. He drew the attention of the FTA community, for instance, to causal layered analysis, which aims to create transformative spaces for the creation of alternative futures (Inayatullah 1998).[3] Other examples are immersive decision theatres (offering a virtual environment facility to visualise output of predictive and scenario-based models with the aim to support decision-making (Edsall and Larson 2006)[4]), transformational narratives[5] and Integral Foresight methodologies. The latter introduces Integral Philosophy into foresight, based on the argument that the answers required today cannot, in principle, be found in what Slaughter (2008) calls 'problem-oriented' futures (i.e. conventional thinking), and thus requires a new approach making use of integral ideas.

Boden, Johnston, and Scapolo (2012) give some responses to these new demands on FTA. They pose a tentative claim that 'FTA and the issues it brings to prominence need to catalyse major innovations in organisations and governance', building on the argument that existing governance structures and organisations need to better adapt to the scale and nature of current Grand Challenges. With a similar line of thought in his keynote at the 2011 FTA Conference, Ollila (2011) from Nokia focused on the future challenges for innovation policy as resulting in particular from global economic developments. He argued that innovation policies should be better fine tuned to support the emergence of innovation networks and innovation ecosystems. He saw innovation policies as horizontal policies that cover the whole innovation system by shaping a favourable innovation environment. This approach, dixit Ollila, calls both for new structures and competencies, and for innovation policy based on a networking approach.

The papers presented in this special issue address the above issues by exploring from different angles the growing demand for forward-looking intelligence in times of crisis and uncertainty, and by proposing FTA as a key instrument to help prepare for and tackle societal challenges. First, three contributions explore new avenues of how FTA could be conceived in the future by discussing and elaborating theoretical groundings, and what their potential and limitations are in

addressing Grand Challenges. Four further contributions analyse concrete cases of advanced FTA practices in areas that are characterised by high degrees of complexity and uncertainty. These contributions point to possible future directions to be followed by FTA in order to better cope with Grand Challenges.

The arguments in the keynote of Ollila are in line with a tendency of the private side to claim that they are better prepared for the future than the public side. The question arises whether this is actually the case, or whether it 'produces fictional certainty that leads to managerial overconfidence and blindness to true novelty and uncertainties', as argued by Tuomi. On the public side, he wonders whether elderly people will really constitute a Grand Challenge, or whether they will become the dominant productive force in the next decades. Tuomi kicks off a set of contributions that look more conceptually at how FTA can contribute to identifying and addressing complex challenges. He invites us to think differently about Grand Challenges, by zooming in on the issue of unpredictability, in line with Linstone's argument on the limitations of forecasting in times of transition between two eras. Future-oriented technology analysis frequently fails to grasp socially and economically important technical developments. Tuomi looks at epistemic and ontological causes for this failure, by introducing the idea of 'ontological unpredictability' and showing how innovation leads to unpredictability that cannot be removed by more accurate data or incremental improvements in existing predictive models. Based on the presented analysis, his paper clarifies the reasons why policy, strategy and future-oriented analysis need to move beyond evidence-based approaches. Tuomi sees only a limited role for the identification of weak signals in understanding the future, as they can only be detected after the fact, when the future is already here. They can, however, enhance our capability to make distinctions so that we are better able to live in an unpredictable world.

FTA's greatest obstacle is ignorance. Loveridge and Saritas align with Linestone in that they point to the problem of ignorance, and the need to admit it. Their starting point is that FTA deals with phenomenological ignorance of three kinds (known unknowns, unknown knowns and unknown unknowns) that give rise to an over-reliance on subjective opinion. These invade both the qualitative and quantitative pieces of information that are joined to create outcomes for policy and management in all the STEEPV themes (Social, Technological, Economic, Ecology, Politics and Values and Norms). FTA then becomes an imaginative projection of the current knowledge in which formal methods and techniques play a subsidiary role following Wittgenstein's dictum that 'methods pass the problem by'. These contentious matters form a platform for discussion and the authors conclude that FTA's practical outcomes are underpinned by subjective opinion in many dimensions. This tendency is likely to increase as FTA becomes involved with technologies of great social and commercial complexity. In brief, it comes down to being always prepared for the unknown unknowns, which has in fact structural implications for the resilience of societies.

In order to navigate foresight in the sea of expectations, one needs both clear sight as well as a compass. The argument of Loveridge and Saritas that FTA is an imaginative projection of current knowledge is further explored by Van Lente, who looks at the literature on the sociology of expectations and what it can offer for foresight. His paper investigates the phenomenon that socio-technical developments are saturated with formal and informal anticipations and discusses the implications of this situation for foresight. The key features of foresight approaches are reviewed against the background of this observation, as well as the main results of the sociology of expectations, which studies the informal production and circulation of expectations in science and technology. He derives three generic lessons from the sociology of expectations and discusses how these support or limit the ambitions of foresight.

Should a firm match its foresight approach with the types of uncertainty it faces? Vecchiato kicks off a set of four contributions on concrete cases of how FTA is used in addressing complexity and uncertainty. He looks at corporate organisations that recently faced major changes and increasing turbulence in their external environment in order to explore how decision makers select and use foresight practices and techniques for handling environmental uncertainty. He expands the understanding of environmental uncertainty by defining the concept of 'boundary uncertainty', which regards the identity of the components of the business (micro) environment. Vecchiato distinguishes between 'continuous' and 'discontinuous' drivers of change and explores their implications for strategic foresight.

How do businesses develop successful continuity and become economically wealthy while simultaneously following their vision of the tenets of sustainable development? Cagnin and Loveridge focus on innovation networks by suggesting a dynamic framework of continual learning that enables a business to develop a capacity to anticipate and address change within the networks in which it is embedded, using FTA thinking to shape a pathway of a business towards sustainable development. The objective of the framework is to help organisations create a tailored, as well as a common strategy in their network of relationships, with support of FTA, in order to achieve coherence among network partners in progressing towards higher levels of sustainability. They argue that, in addition to governments, firms should also take a share of the responsibility for educating society and promoting active citizen participation in decision-making through inclusive dialogue. They see a key role for FTA approaches and methods in this.

How to navigate in a landscape of interrelated innovation systems? Ahlqvist, Halonen, Eerola, Kivisaari, Kohl, Koivisto, Myllyoja and Wessberg look at the role of research and technology organisations (RTOs), and the difficulties they face in the complexity of interconnected innovation systems. They argue that RTOs face a systemic-temporal paradox: their strategies should simultaneously be based on a 'culture of inertia' (on the historical paths), and on a 'culture of swiftness' (on the constantly forming potentialities of the future). In line with this, they claim that RTOs would benefit from developing two systemic capacities: partial structural openness enabling flexibility in organisation, and an anticipatory culture that builds on an anticipatory agency, that is, a proactive participatory approach that leads to action. They show how process-based road mapping can be applied in building systemic transformation capacities and anticipatory culture, and present four case studies of road mapping projects from the Technical Research Centre of Finland (VTT).

How to forecast technologies that depend mainly on discontinuous advances? Guo, Ma, Porter and Huang propose an approach to address the highly uncertain dynamics of New & Emerging Science & Technologies (NESTs). NESTs pose special challenges to traditional forecasting tools. The authors explore how the 10-step 'Forecasting Innovation Pathways' analytical approach can be systematised through the use of Tech Mining. They combine qualitative and quantitative tools in aiming to identify potential innovation pathways. The approach proposed is applied to the development of Dye-Sensitized Solar Cells (DSSCs), and shows potential to capture key technology and contextual attributes that affect the prospects for effective applications, drawing on the practical combination of empirical and expert knowledge.

These thought-provoking papers of the special issue provide a rich spectrum of insights and opinions on the role of FTA in preparing for Grand Challenges. Some common lines of thought seem to emerge around the recognition of fundamental uncertainty and unpredictability. Such notions lead several authors to remind us on the role of FTA to challenge persisting premises on extrapolated futures based on past events. Stronger emphasis on creativity and exploration of truly

alternative future developments are called for to be better prepared to address both the existing Grand Challenges and those to emerge in the future.

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†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.

Notes

1. Call for papers, Fourth International Seville Conference on Future-Oriented Technology Analysis (FTA), http://foresight.jrc.ec.europa.eu/fta_2011/FTA2011_call_final.pdf. Last accessed July 2012.
2. A fourth religious/mythological perspective can add to bridging the gap between the systems analysis and the real world. The organisational and the personal perspectives deal with humans, collectively and individually, while the technological and religious perspectives are constructs created by humans (Linstone 2011a).
3. It consists of four levels: the litany, social causes, discourse/worldview and myth/metaphor. Inayatullah (1998) argues that, 'the challenge is to conduct research that moves up and down the layers of analysis and thus is inclusive of different ways of knowing'.
4. Probably the most well-known example is the Decision Theatre at Arizona State University, which constitutes a large research infrastructure (www.decisiontheater.org).
5. See e.g. Denning (2005) on the use of narrative tools in combination with strategic analysis for addressing transformational innovation.

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