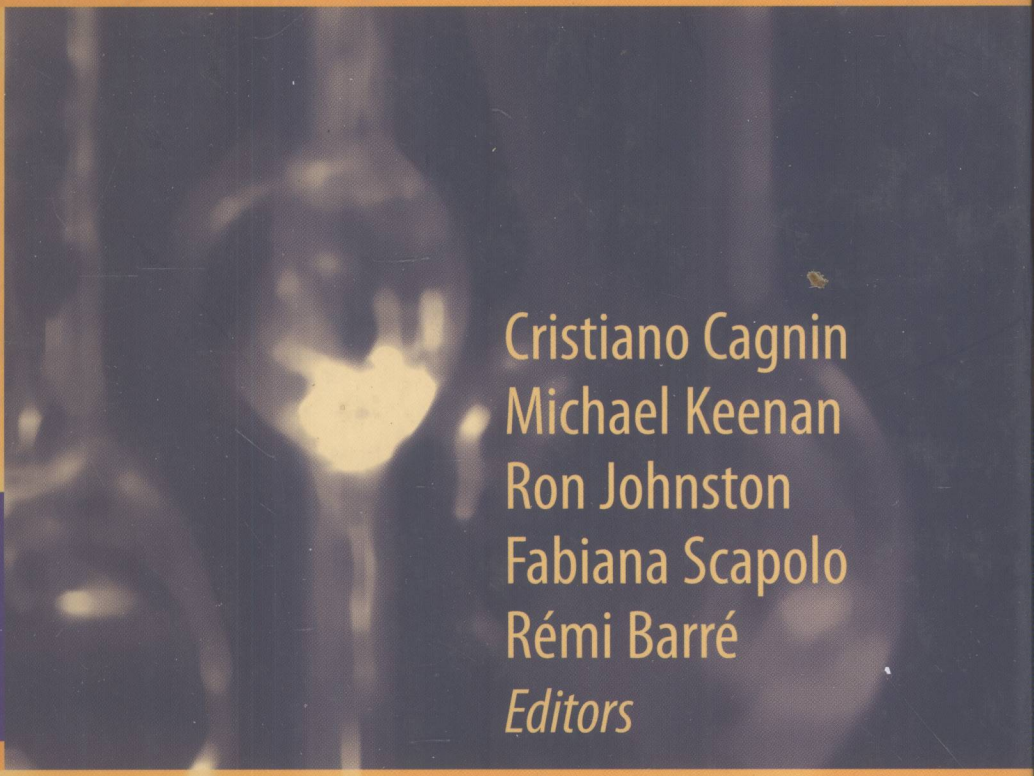

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Future-Oriented Technology Analysis

Strategic Intelligence for an Innovative Economy

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Chapter 1
Positioning Future-Oriented Technology Analysis

C. Cagnin and M. Keenan

1.1 Background

Over the last half century or so, various tools and techniques have been developed that seek to better anticipate and shape future technological developments. Some of these approaches, particularly early on, tended to be techno-determinist in their outlook, but more recently, a greater acknowledgement of the co-evolution of technology and society has led to the adoption of necessarily more complex perspectives. Some approaches have been purely quantitative, others purely qualitative, whilst a mix is often preferred. Some have involved only 'experts', whilst others have sought to initiate a societal dialogue. And some have sought to explore possible futures through extrapolation, whilst others have adopted a more normative stance, identifying targets and setting out action plans for achieving more desirable futures.

A variety of epistemic communities have grown up around anticipating (and, in some cases, shaping) technological futures. Perhaps the best known are the technology forecasters, but there are also other long-established communities around technology assessment, not to mention the broader field of futures studies. More recently, a technology foresight community has developed, which has its roots in the innovation studies field (see Chap. 2 in this volume and Miles 2008). There are some differences between all of these communities – in terms of their roots, practices, and knowledge claims – but there are a far greater number of similarities (see Chap. 3). Indeed, differences within communities are often greater than the differences between them, whilst many individual practitioners clearly transcend different traditions. With this in mind, the European Commission's (EC) Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS) has sought to begin a dialogue between these overlapping communities, using the label *Future-oriented Technology Analysis* (FTA) as a common umbrella term for technology foresight, technology forecasting and technology assessment. Through a series of JRC-IPTS sponsored biennial seminars, these communities have come together to exchange experiences and knowledge. These seminars have culminated in the

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publication of several journal special editions[1] and the production of this book.

As a result of this activity, some progress has been made – through mutual learning and exchange – towards the development of a shared understanding, though some work remains to be done before a fully-fledged FTA community can be said to have emerged. This is most obviously reflected in the bias of many of the contributions in this volume towards technology foresight, with fewer contributions on forecasting and technology assessment. This may lead the reader to equate FTA with technology foresight, but this would be a mistake. If anything, the technology forecasting and technology assessment communities are more mature and developed than technology foresight and have much to offer to the development of a more broad-based FTA. At the same time, the ever-growing popularity of (technology) foresight offers new opportunities for experimentation and innovation and the chance to employ FTA in more varied settings. Increased knowledge-sharing and even collaboration between different communities could therefore benefit all concerned.

In the remainder of this introductory chapter, we first outline work done around tracing the evolution of FTA and its essential characteristics. We then discuss the relationship between FTA and decision-making processes, an area where there exists much misunderstanding and misplaced expectations. Thereafter, we explicate some of the main challenges facing contemporary FTA, particularly around impacts and their assessment, while in a final section, we provide a summary of the chapters that follow.

1.2 Generations and Principles

To understand present-day FTA it is important to recognise that many of the successful approaches and methods which are still widely used today were developed during the 1950s and 1960s, undoubtedly influenced by the context of the Cold War. During the 1970s there was an extension of frameworks used mainly to better understand and shape technology developments into better understanding social needs and what society might expect of science and technology (S&T) in fulfilling their expectations as well as how to develop in such a context. This has anchored FTA, up to the present, firmly in the relation between science and technology on the one hand, and social needs on the other. According to Loveridge (2001), it was also during the 1970s that the limitations of traditional planning within industry were recognised, particularly in the light of major unpredicted events, such as the

[1] For example, see special editions of *Technological Forecasting and Social Change* vol. 75(4) and *Technological Analysis and Strategic Management* vol. 20(3) as well as *Technological Forecasting and Social Change*, vol. 72(9).

1973 oil crisis. Since then, there has been a substantial shift away from the apparent certainties of the Cartesian era of modelling and management, towards more contingent approaches, in both business and the public sector.[2] Indeed, most FTA practitioners today acknowledge and take into account the co-evolution of S&T and society in their work.

These shifts in FTA approach have been characterised by a number of authors as moving through successive generations or phases (Johnston 2002,2007; Cuhls 2003; Georghiou 2001,2007). Perhaps the best known of these generation models is the one proposed by Georghiou for technology foresight, where he identifies five generations. In the first generation, the focus is on forecasting of technological developments or the internal dynamics of technology, with ownership in the hands of experts. In the second generation, the focus is on the interplay of technology and markets. Technological development is understood in relation to its contribution to and influence from markets, and participation happens across the academic-industrial nexus. In the third generation, the market perspective is enhanced by inclusion of a broader social dimension, involving the concerns and inputs of social actors, and with a user-oriented (i.e. customer) perspective. The methods used and the knowledge base drawn upon are expanded to deal with issues concerning social trends and alternative institutional arrangements. In the fourth generation, foresight exercises have a distributed role in the science and innovation system, and often multiple organisations carry on exercises that are specific to their own needs, but which are coordinated with other activities. Finally, in the fifth generation there is a mix of foresight exercises which are distributed across many sites, and the concern of these activities is either on structures or actors within the STI system, or on the scientific/technological dimensions of broader social and economic issues. It is important to highlight that these generations are ideal types and that in practice they are not mutually exclusive. Indeed, it is not uncommon for exercises to exhibit characteristics of more than one generation. Nevertheless, many practitioners have moved towards the more recent of these generations in their activities.

Perhaps in contrast to such generational models, other authors have attempted to distil the essence of FTA (e.g. Gavigan et al. 2001; Keenan and Popper 2007), which has seen the explication of principles, as shown in Box 1.1. Such principles can be used to distinguish FTA from other decision-support techniques and can provide novice practitioners with a checklist of essential characteristics that their FTA activities should aim to have. Prominently emphasised is the future-orientation of FTA, as are the principles of participation and action-orientation. The latter is a particularly important consideration, with much attention paid to how FTA should relate to decision-making processes.

[2] For more on historical reference see: Loveridge (2001), Cagnin and Scapolo (2007) and Georghiou (2007) as well as Chap. 2 of this book.

Box 1.1 FTA Principles (Keenan and Popper 2007)

Principle of future-orientation: FTA is a future-oriented activity, though not in a predictive sense. In fact, FTA assumes that the future is not pre-determined, but can evolve in different directions, depending upon the actions of various players and the decisions taken today. In other words, the future can be actively shaped, at least to some extent, and there is a certain degree of freedom to choose among alternative, plausible futures, and hence to increase the likelihood of arriving at a preferred (selected) future state.

Principle of participation: FTA values the multiplicity of perspectives, interests, and knowledge held across a dispersed landscape of actors, and seeks to bring these together in processes of deliberation, analysis, and synthesis. Thus, FTA is not the preserve of a small group of experts or academics but involves a wider number of different groups of actors concerned with the issues at stake. Moreover, the results of FTA often have implications for a wide variety of actors, so it is important to involve these as far as possible throughout the process.[3]

Principle of evidence: FTA relies upon informed opinion and interpretation, as well as creative approaches in formulating conjectures on the future. However, these are seldom sufficient on their own and are complemented with various sorts of data from trend analyses and forecasting, bibliometrics, and official statistics, among other sources. Clearly, the future cannot be known with certainty and it is impossible to test conjectures on the future in the same way as one might test scientific knowledge claims. However, the plausibility of conjectures – as well as the original insights that they bring – are essentially 'market tested' by the decision-makers who rely upon such information. If they are to be convinced of the worth of FTA, then results should be based upon a sound knowledge base.

Principle of multidisciplinarity: FTA recognises that many of the problems we face today cannot be understood from a single perspective nor the solutions foundwithin a single discipline. Accordingly, FTA intentionally seeks to transcend traditional epistemic boundaries, bringing together different

[3] Daheim and Uerz (2006) have coined the term "open foresight", which is strongly linked with the concept of open innovation (Georghiou 2007). This refers to the involvement of relevant stakeholders, both from inside and outside the target organisation, hence promoting networking (Martin and Johnston 1999) and acting as a means of disturbance for the organisation. Thus, according to Georghiou (2007), FTA approaches should also be used to bring together not only those responsible for the development of the technological or other knowledge needed for innovation, but also those who are likely to make use of the technology or to provide the regulatory environment in which it develops. Moreover, it is extremely important that senior management within firms or policy makers feel ownership of FTA results through direct engagement. Therefore, involvement and engagement of key personalities in positions of influence, both in firms and in government, is key to enable FTA approaches to attain the expected impacts and benefits in the policy and decision making system.

(continued)

Box 1.1 (continued)

disciplines in processes of deliberation that result in improved understanding and new working relationships.

Principle of coordination: FTA enrols multiple actors to participate in decision arenas where conjectures on the future are contested and debated. Supported by various data and opinion, the FTA process aligns participant actors around emergent agendas, resulting in a coordinated mobilisation of people and resources.

Principle of action orientation: FTA is not only about analysing or contemplating future developments but supporting actors to actively shape the future. Therefore, FTA activities should only be undertaken when it is possible to use act on the results.

1.3 FTA and Decision-Making Processes[4]

Policy and strategy development are increasingly being interpreted as a continuous reflexive learning process that underlines the need for 'systemic instruments' (Smits and Kuhlmann 2004) to complement traditional steering approaches. FTA has the potential to offer such a set of systemic instruments, although there is still much debate around its interface with the policy process. Focusing upon technology foresight, a recent debate at the JRC-IPTS on the functions and benefits that foresight might have in the policy making system has given rise to the idea that there may in fact be two modes of foresight,[5] and perhaps similar modes apply to other FTA approaches:

- In 'mode 1' foresight, the objective is to improve and optimise the existing system, even if the process somehow pushes at boundaries through gradual evolution and incremental changes. Accordingly, policy and decision makers can easily become partners of the process because they have much to win from a more efficient system. The foresight process itself can be adapted to suit particular policy conditions and requirements (Weber 2006; Eriksson and Weber 2006; Havas et al. 2007).
- In 'mode 2' foresight, the aim is to debate and promote fundamental changes of established paradigms. This applies when the current system is perceived to be

[4] This section builds upon work carried out as part of the FORERA (Foresight for the European Research Area) Action within the JRC-IPTS, specifically around mutual learning workshops organised as part of the ForLearn project. For further information, see Da Costa et al. (2007) or visit the website: http://forlearn.jrc.es/guide/0_home/index.htm

[5] This is the summary of part of the results of the debate which took place in the last of a series of four mutual learning workshops, or consolidation workshop, focusing on the impacts of foresight on the policy making system. For more information see http://forlearn.jrc.es/guide/0_home/index.htm

fundamentally unsustainable and thus it becomes necessary to transcend it and to build a new system based upon different conditions and assumptions. Thus, 'mode 2' foresight is about questioning the existing system, initiating disruption, undermining existing world views, and raising the spectre of the incredible. Within this mode, it may be more important to highlight discrepancies than to emphasise consensus. As far as policy and decision making are concerned, one of the most important characteristics of 'mode 2' foresight is that decision makers are unlikely to control the process. Indeed, they may have much (or perceive to have much) to lose within a redefined system and might, therefore, become fierce opponents of such foresight exercises.

In other work carried out by JRC-IPTS, four basic types of structured (stakeholder) dialogue that characterise an ideal FTA exercise have been identified, each of which can be considered a different stage that has to be shaped and tailored in such a way as to attain expected impacts in the relevant policy and decision making system. These stages are as follows: (1) understanding the current situation, (2) exploring what could happen, (3) debating what stakeholders or participants would like to happen, and (4) deciding what should be done.

In the *first stage* – understanding the current situation – FTA approaches produce a number of insights about the future, such as the dynamics of change, new perspectives on the future, an understanding of future risks and opportunities, the definition of possible strategic options, a comprehension of system capabilities, an appreciation of the views of different stakeholders, etc. The anticipatory intelligence that results can improve the knowledge base of decision-making conceptualisation and design.

The *second stage* – exploring what could happen – is one of projection and exploration, carried out in 'hybrid fora' of actors who may have few opportunities to exchange views and may even hold opposing interests. Through a collective dialogue around the future, different interest groups can develop a shared understanding of the current situation, of the issues at stake, and of future challenges. Furthermore, individuals participating in the process can develop more "future-oriented" attitudes, and therefore make better informed choices and be ready to better accept and encourage changes going in the direction of any emerging shared vision.

In the *third stage* – debating what stakeholders or participants would like to have happen – FTA can contribute to an improved mode of governance in multi-layered and multi-actor decision making arenas. This stage improves transparency and can provide a legitimacy and efficiency to the decision making process, thereby increasing the acceptance and credibility of decisions (Martin and Johnston 1999).

The *fourth stage* – deciding what should be done – is not always tackled within the FTA process, and some practitioners argue that it should not be part of an FTA exercise at all, but rather a distinct political stage. Nevertheless, anticipatory intelligence is not always easily translated into options for decision making, especially if it originates from a collective process. Moreover, in a participative process, decision makers might be reluctant to communicate their hidden agendas or their needs to participants. Therefore, the translation of anticipatory intelligence into options for decision making

has to take place with those responsible for making such decisions or with the key personalities in positions of influence, both in firms and in government.

1.4 What We Would Like to Know About FTA but still Don't

Over the past decade, FTA activities have multiplied across a wide spectrum of settings and at different levels. Reflecting this rich diversity of contexts, FTA activities have assumed a range of labels (e.g. technology foresight, technology assessment, technological forecasting, horizon scanning, technology road-mapping, critical technologies), have multiple objectives and rationales, and have used different methodological designs. By extension, expectations of outcomes and impacts tend to be context-dependent, and vary from concerns with the take-up of FTA knowledge in policy and investment decision processes, through to organisational vision-building or the active inclusion of normally excluded groups in decision-making processes and fora. This variety might suggest that different objectives, methodologies, and expected impacts can somehow be related to different contexts and conditions.

However, at the current time, there is still little understanding of the relationships among these variables, leading to a situation where much reinvention occurs in many settings. It can be argued that there is a need for some stock-taking of FTA activities, with a view to identifying patterns of relations between these variables that could serve policy-making or decision-makers in their contexts. This would be extremely relevant in the context of industrialising countries as FTA approaches still hold the promise of bringing about many benefits in such a context.

The challenge therefore is to better elucidate the relations between FTA context, content and approach, with a view to exploring the possibility of designing activities that are fit for purpose. Whilst many FTA practitioners argue that 'recipe books' are not possible for FTA activities given the various contingencies at play in any particular context, it should be possible to demonstrate that, for example, some methodological approaches are better suited than others in certain situations. Alternatively, notions of 'systemic' and 'adaptive' FTA, where FTA activities are responsive to evolving environments, provide a different approach to the design challenge. The definition of general limits of FTA and how these might be relayed in the management of expectations surrounding such activities is also important in addressing such a challenge.

At the same time, pleas from sponsors of FTA activities for better accounts of demonstrable impacts are as old as FTA itself. Yet, little work has been done in this area, with most accounts of impacts confined to individual case study descriptions. Practitioners are inclined to contend that evaluating the impacts of FTA activities is difficult, on account of their 'behavioural additionality', their distribution across a system of actors, and delayed effects associated with the time horizons involved, to name but a few reasons. The evaluative demands of sponsors are also often dismissed as being ill-informed and therefore unreasonable, relying upon overly-narrow linear models of cause-effect that draw upon rational models of decision-making. On the

other hand, from the sponsors' perspective, without better and fuller accounts of impacts, the future sponsorship of FTA activities (and certainly their wider diffusion and expansion) is rendered more difficult and places the whole activity under threat.

It is therefore reasonable to conclude that FTA practitioners need to pay greater attention to accounting for outcomes and impacts before their activities can ever be more mainstreamed. More and better accounts of impacts from case studies could help to increase our understanding of FTA and its effects, but will be insufficient on their own. There is now a need to submit FTA practices to interpretation of their significance by the relevant disciplines of the social sciences and humanities (SSH). In this regard, some work has already been done in closely related areas, such as programme evaluation, futures studies, planning, and the study of evidence-based policy and scientific advice regimes. Extension of concepts and theoretical insights from these areas might therefore prove fruitful. But it is likely that a wider examination of FTA is now required, drawing upon relevant SSH disciplines, such as epistemology, political science, sociology, economics, and management and organisation science. These will provide a variety of interpretative lenses that offer the possibility to expand our conceptualisation of FTA, which will in turn improve the prospects for evaluating processes and outcomes (for example, through the development of suitable indicators).

The implications of what we know and what we don't are played out in different policy settings and contexts around the world. But besides public policy processes, FTA is also widely applied in other areas of socio-economic life, such as business and higher education. Considering business first, there is evidence that an increasing number of firms, industrial associations and industry foundations are using FTA tools for a variety of reasons, including horizon scanning (e.g. of weak signals), strategy setting, development of corporate visions, portfolio analysis, and as an aid in the management of supply chains. The tools being used include technology road mapping, scenario planning, internal and external surveys, and visioning, among others. Whilst there are a few descriptions in the literature of this work, there has been little coverage of how FTA activities fit into the firm (i.e. their embeddedness), how they relate to (innovation) strategy, and the conditions for their impact (or otherwise). Furthermore, outside of the firm, many industrial associations have used FTA tools to provide future-oriented insights for their sectors and to build collaborative linkages among members. In some instances, the public sector (mostly national and regional governments) has sought to promote private sector use of FTA approaches, particularly in small and medium-sized enterprises and towards the further development of industrial clusters. Again, little of this activity has been reviewed and critically analysed. The challenge therefore is to examine the implementation and use of FTA approaches in (and for) the private sector emphasising the impacts of FTA activities, linking their analysis to actual practice, to theories of the firm, to the innovation strategy literature, and so on. The embedding of FTA tools and concepts in companies is, from the organisational point of view, as interesting for analysis as the implementation approaches (e.g. results) enacted by associations, foundations or the like.