Chapter 2
Historical Review of the Development of Future-Oriented Technology Analysis

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2.1 Introduction

The origin of the term 'future-oriented technology analysis' can be traced to the planning for the IPTS Seminar 'New Horizons and Challenges for Future-oriented Technology Analysis: New Technology Foresight, Forecasting and Assessment Methods' held in Seville, Spain in May 2004 (IPTS 2004). In the run-up to this seminar the Planning Committee prepared a preliminary paper to stimulate the potential participants to select topics on which to present papers and posters. This paper was entitled 'Technology Futures Analysis: Toward Integration of the Field and New Methods' (Technology Futures Analysis Methods Working Group, 2004). The paper introduced what it called an umbrella concept to encompass the wide variety of technology-oriented forecasting methods and practices, namely, Technology Futures Analysis (TFA). It is interesting that between that point and the actual seminar, a subtle, but crucial change took place in that TFA became FTA. The essence of that change was that 'technology-oriented' gave way to 'futures-oriented'. This indicated that the focus of the seminar would be clearly on the future and ways to develop useful information for shaping the future. The preparatory paper itself fostered the change in focus as it developed a series of challenging questions about the field of analysis of possible and desirable futures" (Scapolo 2005).

The objective of the Seminar 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), and the reliability of source information.

To understand the power of the umbrella term of FTA, it is necessary to examine the nature and historical development of each of the component concepts.

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2.2 Forecasting and Foresight

The drive to understand and reveal the future is almost as ancient as human history and human inquiry. All cultures and civilizations have produced their prophets, seers, oracles, shamans or 'witch doctors', seeking insights through stars, animal entrails, cloud patterns, seasonal variations or hallucinogenic experiences. Indeed, it can be postulated that notions of past and future are an integral aspect of 'homo sapiens' and our own remarkable evolution.

There have been a number of historical analyses of the emergence and evolution of foresight and forecasting. Cuhls (2003) has provided a detailed account of the achievements and failures of technology forecasting over four decades. Georghiou (2001) proposed that the evolution of foresight could be characterised in terms of three successive generations, which has subsequently been extended to five generations (Georghiou 2007). Johnston (2002) proposed five stages in the chronology of foresight, with technology forecasting and futurism leading to technology foresight, from which emerged foresight, with its wider understanding of the economic and social processes that shape technology.

Looking back in more detail, it can be seen that it was the scientific progressives who lead the way, despairing of a world dominated by the horror of the First World War followed by the Depression, and who called for a new world order which looked to science and technology as a primary means of redemption. Prominent among them was H.G Wells, whose first major publication serialised in a magazine was subtitled, "An Experiment in Prophecy", He anticipated what the world would be like in the year 2000, with accurate predictions of modern transport resulting in the dispersion of the population from cities to suburbs, moral restrictions declining as men and women sought greater sexual freedom; and the formation of a European Union. He also argued, in a BBC broadcast in 1933, of the need for professors of foresight "we are surrounded by numerous professors of the past, but not one of the future" (Miles and Keenan 2003).

In the 1950s the US Department of Defence, looking at the development of new weapons systems, faced two specific needs:

> 'the need for a methodology to capture the reliable consensus of opinion of a large and diverse group of experts and the need to develop simulation models of future environments which would permit various policy alternatives and their consequences to be investigated'. (Bradfield et al. 2005)

The first led to the Delphi technique, the latter to systems analysis and scenario planning, developed within the RAND Corporation. However, it was the particular conditions of the 1960s that gave birth to the contemporary form and practice of foresight. The demonstrated effectiveness of operations research, leading to the growing influence of systems theory and thinking, together with the strategic challenges of the Cold War, provided a climate in which organised thinking about the future flourished. In contrast to the nineteenth century theories of social change, which dealt with large impersonal processes of evolution, the new approach was based on the deliberate intervention to direct change for specified ends.

In France, the Futuribles project was launched. In the UK, a 'Committee on the Next Thirty Years' was established. In the US, Herman Kahn left the RAND Corporation to establish the Hudson Institute, where he initiated a series of major studies on the future addressing economic and social policy issues, as opposed to his previous military focus. Daniel Bell (Kahn and Wiener 1967, p.xxv) attributed this emergence to the effects of economic recovery and growth:

> It arises from the simple fact that every society today is consciously committed to economic growth, to raising the standard of living of its people, and therefore to the planning, direction and control of social change. What makes the present studies, therefore, so completely different from those of the past is that they are oriented to specific social-policy purposes: and along with this new dimension, they are fashioned, self-consciously, by a new methodology that gives the promise of providing a more reliable foundation for realistic alternatives and choices, if not for exact prediction.

And the new methodology?

> We have begun to assemble statistical time-series both to plot trend lines and to extrapolate likely developments. The existence of a trend is no necessary guarantee that it will continue; but knowledge of trends and curves gives us more knowledge of likely developments. Along with time-series, we have begun to construct models or likely combinations of trends and developments in order to uncover the connections and causal relations between variables. And finally, with such simple techniques as the Delphi method, we seek to impose some controls by checking the informed guesses of one set of observers with those of others. (Kahn and Wiener, pp.xxvii–xxviii)

Kahn was appropriately prosaic in addressing the question of why we should speculate far ahead. Not because we could predict the future, but because:

> Such studies, even if only partially successful, contribute to interesting lectures, provocative teaching and stimulating conversation, all of which can broaden horizons and increase creativity – by no means negligible benefits. More important, these studies can affect basic beliefs, assumptions and emphases. Probably most important, is that long-range studies provide a context in which to do 5- and 10-year studies that can and do influence policy choices. (Kahn and Wiener, p.1)

While the initial focus was on public policy, it soon attracted the interest of the business community. Royal Dutch Shell initiated a 'Year 2000' study in 1967, which identified that the historical trajectory of year-on-year expansion could not continue, and that the oil industry faced a discontinuity. Pierre Wack, a planner at Shell Francaise, who was familiar with Kahn's work, proposed:

> To experiment with scenario planning as a potentially better framework for thinking about the future rather than continuing to rely on conventional forecasts which were likely to be wrong in the face of a discontinuity. The initial scenarios developed in 1971 … proved extraordinarily successful in that they correctly identified an impending scarcity of oil and an ensuing pointed increase in oil prices; shortly thereafter scenario planning was extended throughout the company (Bradfield et al. 2005, p.798).

Companies were also included in the national forecast (today we would say foresight) activities in the USA (Gordon and Helmer 1964) and in Japan (Kagaku Gijutsuchô Keikakukyoku 1971). This was also the time when the first scenario approaches were tested (Kahn and Wiener 1968). It is reported (Bradfield et al.

2005, p.798) that General Electric also produced four alternative scenarios in 1971 of the global and US economic and socio-political conditions in 1980.

The growth in the application of foresight in the corporate sector was apparently quite strong during the 1970s and early 1980s, and is well-documented. A survey of US companies in 1981 found limited use prior to the oil crisis of 1974, but a substantial surge after that date, such that by the early 1980s, almost half of the US Fortune 1,000 industrial companies were actively using foresight techniques in their planning processes. The companies using foresight were characterised by their large size, planning horizons of more than 10 years, and capital intensity, as in the aerospace, chemicals and petroleum industries (Linneman and Klein 1979, 1983).

The pattern of adoption of foresight in planning was largely similar in European companies. Malaska (1985) Malaska et al. (1984) reported a period of experimental adoption of foresight techniques after 1973 and strong growth between 1976 and 1978, mainly on the part of large companies in capital intensive industries with long planning horizons such as petroleum, motor vehicles, and power supply.

The UNIDO Technology Foresight Manual (2005) reports:

> In the last two decades several large enterprises in such diverse sectors as energy, automotive, telecommunications and information technology have established foresight groups and strategic planning processes, which analyse the long-term prospects of new technologies and their impact on markets and corporate strategies. DaimlerChrysler's Society and Technology Research Group (STRG) is one of the first future research groups to be established within a company. Since 1979 it has investigated, in close cooperation with its customers, the factors shaping tomorrow's markets, technologies and products.

The use of foresight blossomed from the mid 1990s. Most OECD member countries (i.e. the advanced industrial nations), almost all European countries, and many Asian and South American countries have conducted national foresight studies (Johnston 2002). Over this period, there has been an increasing shift away from methodology-driven foresight studies, towards recognition of the variety of tools available to conduct foresight studies, each suitable for different purposes and with different strengths and limitations. The majority of these studies have been conducted at the national level. This reflects a stage in the development of the application of foresight to priority-setting and policy objectives. In general, these studies have been formulated and carried out by organisations with a national responsibility with regard to science and technology matters, be they a government department, or a semi-independent advisory body.

A detailed categorisation of national foresight studies has been made against the objectives pursued, which were identified as national competitiveness, vision building, identification of key or emerging technologies, creation of networks, information dissemination and education, and development of a forward-looking culture. It was concluded that "in countries where successive projects have been carried out, one can observe how the evolution in methods employed aims to increase the impact and effectiveness of foresight" (Gavigan and Scapolo 1999).

A particular form of technology forecasting went under the label of 'critical technologies', and was based on the assumption that certain technologies were key to future economic performance, and could be identified. In the US the driver was

largely the fear of economic decline because of a superiority elsewhere, notably Japan, in developing new technologies. These were largely expert-based, and were conducted through the 1990s (Wagner and Popper 2003). Critical technologies foresights are performed elsewhere at national governmental level. The much emulated Japanese Delphi studies are oriented towards identifying critical technologies, although this is now being augmented with societal aspects. Japan has recently completed its eighth exercise of this kind; Korea, its third, and China and India their first (Johnston 2006).

A major promoter of foresight, and more broadly future-oriented technology analysis, has been the Institute for Prospective Technology Studies (IPTS) of the European Commission's Joint Research Centre (JRC, now Directorate General JRC of the EU Commission) located in Seville (Spain). Staff at IPTS have conducted many studies of future technologies and their impacts, and contributed to the development of more effective networks and practice among foresight practitioners.

The European Foresight Monitoring Network, established as a "foresight knowledge sharing platform" under the fifth Framework Program, to monitor foresight activity, now holds details of around 1800 separate foresight initiatives. Undoubtedly, this is an incomplete collection.

2.3 Technology Assessment

Technology Assessment had its origins largely in the United States in the 1970s, but was rapidly imitated and developed elsewhere. Its major objective was to assess the potential and implications of emerging and future technologies. The lead organisation was the US Office of Technology Assessment (OTA) which conducted a wide range of comprehensive, future oriented technology assessment exercises over the period 1974–1995. The OTA studies primarily served to inform Congressional interests as they considered legislative policy options. OTA studies were public and they served to inform the community about emerging technologies with unbiased, carefully reviewed analyses.

In Europe, technology assessment activities continue to flourish in some areas (the German-speaking countries, for example) while the term is practically defunct elsewhere. Presently, the term "technology assessment" is most closely associated with parliamentary activities. Several national and regional parliaments in Europe have their own semi-permanent capacities for TA, some created after the demise of the US OTA, and most recently the European Parliament has signed a framework contract with a group of these parliamentary TA units to provide services to its own panel with responsibility for Scientific Technology Options Assessment (STOA). There is a large, but largely fragmented FTA community in Europe, serving a broad variety of clients at various levels of government, including municipalities, regions, national governments and the various European Institutions.

There have been several attempts to form professional associations in the domain covered by TA. In the 1970s the International Society for Technology

Assessment flourished briefly; the International Association for Impact Assessment followed, and continues to be very active, but lately less involved with technology assessment. The European Society for Technology Assessment (ESTA) was linked with the regular ECTA (European Conferences on Technology Assessment) meetings of the early 1990s. The International Association of Technology Assessment and Forecasting Institutions (IATAFI) faded out of sight in the new millennium.

Most recently the "Netzwerk TA" has been created for the German-speaking countries and has held two conferences. In Germany, Netzwerk TA was preceded by a database and related activities on behalf of the Federal Ministry of Education and Research by Karlsruhe Research Centre's Institute for Technology Assessment and Systems Analysis. These covered the whole of Europe. Most relevant in this context is a still existing newsletter cum scientific journal, currently named "Technikfolgen Abschätzung – Theorie und Praxis" (Technology Assessment – Theory and Practice), which has a distinct knowledge-sharing function.

While there were plans to create some kind of umbrella activity under the label of "European Technology Assessment Network" (ETAN) from the mid-1990s on, the network as originally planned was never realised and the label ETAN was used for relatively small-scale activities.

A recent promising approach is that of the development of an 'early warning' or 'over the horizon' scanning capability in a number of countries, including the UK and Finland, designed to develop awareness and understanding of forthcoming science and technology and their implications. The studies for the STOA panel of the European Parliament have served to pinpoint critical aspects of technologies and their application which might require the attention of legislators at some later point in time.

2.4 Conclusion

With the emergence of the global knowledge economy and the increasing significance of access to knowledge as the basis of economic competitiveness, the importance of being able to 'peer into the future' has become recognised in steadily growing circles. This sets the scene for the Seminar on which this book is based, and for the development, refinement and impact of future-oriented technology analysis detailed in the following chapters.

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