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An industrial technology roadmap for supporting public R&D planning

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ABSTRACT

Technology roadmap is one of the useful tools for managing R&D planning as well as identifying the future of technological progress at firms, various levels of government agencies, and other organizations. This study presents an industrial technology roadmapping process for use in public R&D programs, affecting firms' strategic behavior under this umbrella. The primary purpose of this paper is to address evolutionary aspects of industrial technology roadmap for the South Korea case and provide a more advanced framework of public R&D planning. Since 2000, technology roadmapping has been initiated by the government agency in South Korea, and, more recently, this practice has become popularized in small- and medium-sized companies as well. Despite the popularity, practitioners have some difficulties in finding practical guidelines and systematic processes for developing technology roadmaps applicable to R&D planning within an organization. The framework of industrial technology roadmapping developed by the Korea Institute for the Advancement of Technology can be applied or modified to the R&D planning process of similar projects. This roadmapping process deals with a variety of industries with different characteristics, and provides a systematic mechanism to predict future market demands and technology innovations. Finally, this paper shed some lights on the major challenges, potential roadblocks and proposed recommendations in roadmapping process.

1. Introduction

Technology forecasting is valuable in the aspect to give guidance for the direction of promising technology development. The value of technology forecasting lies in its usefulness for making better decisions, not in its coming true (Martino, 1993; Isenson, 1966). Technology forecasting is, in other words, typically approximations of the future and cannot include all exact future forms (Isenson, 1966). Technology forecasting strives not only to identify research and knowledge gaps in order to find the right path to reach goals, but also in order to search ranges of the environment that will be encountered in the future.

Technology forecasting attempts to reveal a specific characteristic or an attribute of technology over a designated time. Joseph Martino defines technology forecasting as "a prediction of the future characteristics of useful machines, procedures or techniques" (Martino, 1993). During the 1950s and 1960s, technology forecasting (TF) was mainly driven by military competition with the Soviet Union (Coates et al., 2001; Porter, 1999). TF was initiated primarily as a tool to help anticipate military technology needs and to help plan and prioritize R&D and system development (Porter, 1999). Hal Linstone pointed out that technology forecasting (TF) seems to have peaked around 1970 with a decline in methodological advances thereafter (Coates et al., 2001). In historical perspective, the use of TF methods is summarized in Fig. 1.

On the other hand, since 1960's, long-range planning has been increasingly used by corporate management due to the increased competition among firms, speed of technological change, and fast advancement in information technology (Payne, 1971; Fulmer and Rue, 1974). Erich Jantsch and Robert Ayres Erich in the last half of the 1960's described that the company started to focus on the integration of technological forecasting with long-range planning, and the implications for organization structure and operations (Bright, 1968; Ayres, 1969). Environmental scanning element stands at the juncture of forecasting, foresight, and strategy (Martino, 2003; Donald, 1981; Fahey et al., 1981; Slaughter, 1999; Beat, 2000). The corporate community has focused its efforts on environmental scanning such as bibliometric/patent trend analysis (Martino, 2003; Porter and Detampel, 1995) and market analysis to identify increasingly diversified needs of customers (Fahey et al., 1981), in order to establish a solid grasp of technology initiatives as well as to improve its future position. In addition, a company should set up its R&D strategy in alignment with its business strategy such as manufacturing, sales and marketing, personnel, finance, and accounting. Many organizations have investigated major breakthrough technologies, core technology improvements, and state-of-the-art defining technologies. A technology forecasting tool for decision-making is needed to predict future technology trends now more than ever before.

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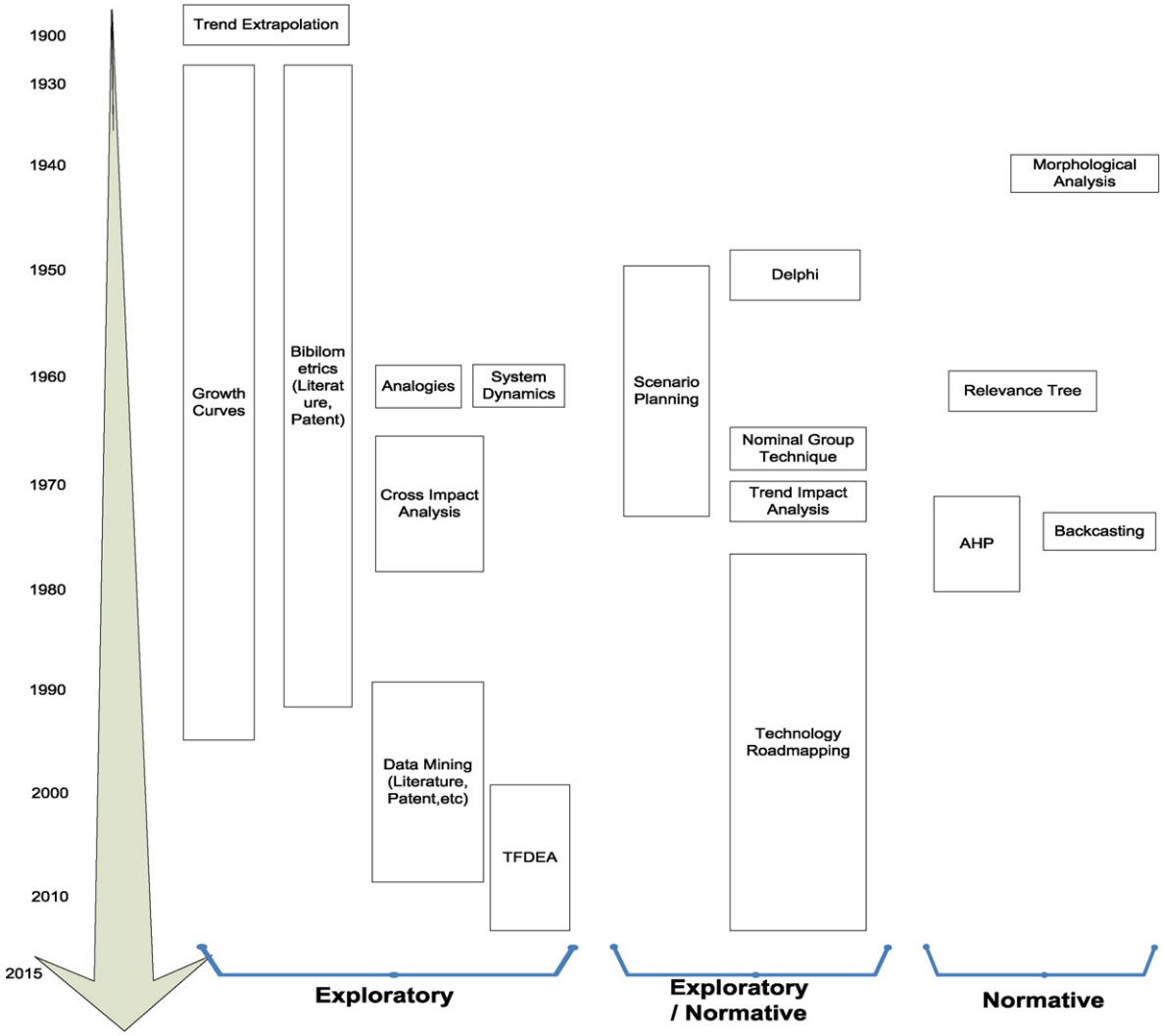

Fig. 1. The chronological tree of technology forecasting techniques.
Source: modified from (Cho, 2013).

A variety of technology forecasting methods have been introduced and applied to various technologies, business units, industries, and organizations by diverse purposes. But in the last four decades, especially after the widespread availability of information technology, some of the approaches using much information like patents, journals, research awards, business press, newspaper, and internet social media, have

Table 1
Technology forecasting techniques.

Approach	Techniques	References
Environmental scanning	-Bibliometric analysis	Porter and Detampel (1995), Dereli and Durmusoglu (2009a, 2009b),
	-Patent landscape analysis, patent alert system, and fuzzy-based clustering	Millett and Honton (1991), de S. Price (1965) Callon et al. (1979), Ellis et al. (1978), Callon (1986), Frawley et al. (1991), Kostoff (1991), Kostoff (1994)
	-Data mining, text mining, database tomography, and tech. mining	Feldman and Dagan (1995), Cunningham et al. (2006)
Stochastic forecasting	-Probabilistic trends and time lags	Martino (2003)
Trend extrapolation	-Multiple regression, multivariate regression, etc.	Martino (1993), Lenz (1962)
Growth curves (S-curves)	-Pearl, logistics, gompertz fisher-pry, bass diffusion model, and life cycle analysis	Martino (1993), Robertson (1923)
Time series analysis	-AR, MA, ARIMA	Millett and Honton (1991), Lenz (1962), Bradfield et al. (2005)
Measure of technology	-Scoring model and technology frontier	(Martino, 1993; Souder, 1972; Anderson et al., 2001)
Modeling and simulation	-System dynamics and agent-based models	Millett and Honton (1991), Luna-Reyes and Andersen (2003)
Expert judgmental forecasting	-Delphi, survey, FGI, role playing, AHP, analogy model, scenario planning, technology roadmapping, etc.	Martino (1993), Martino (2003), Lenz (1962), Martino (1999), T. F. A. M. W. Group (2004), Daim et al. (2006), Huss and Honton (1987), Saaty (1980), Saaty (1977), Kappel (2001)
Normative method	-Relevance tree, morphological analysis, backcasting, and mission flow diagram	Martino (1993), Jantsch (1967), Wissema (1976), Robinson (1982), Quist and Vergragt (2003)