50 Years of Corporate and Organizational Foresight: Looking Back and Going Forward

Adam Vigdor Gordon,
Aarhus BSS, Aarhus University
Fuglesangs Allé 4, 8210 Aarhus, Denmark
adg@mgmt.au.dk

Mirza Ramic
Aarhus BSS, Aarhus University
Fuglesangs Allé 4, 8210 Aarhus, Denmark
mirza-ramic@mgmt.au.dk

René Rohrbeck,
Aarhus BSS, Aarhus University
Fuglesangs Allé 4, 8210 Aarhus, Denmark
rrohr@mgmt.au.dk

Matthew Spaniol,
Aarhus BSS, Aarhus University
Fuglesangs Allé 4, 8210 Aarhus, Denmark
matt@mgmt.au.dk

Abstract

On the occasion of the 50th anniversary of Technology Forecasting & Social Change, we review the evolution of corporate and organizational foresight within the journal and look ahead to the coming decade. We follow a systematic literature review process to uncover the major contributions in this area of foresight theory and practice covering five decades, and present the fruits of a thorough re-reading and thematic summary of these articles. We reveal the concerns of authors as they have sought to apply foresight in cor-

porations, organizations, and institutions, how they have attempted to resolve them, and the progress they have made. In doing so, we discuss how these authors have cumulatively defined and evolved this portion of the strategic foresight field. We use this information as a base for launching a discussion of the current priorities and future challenges involved in developing further analytical understanding of how companies and organizations may use foresight processes to reach goals and improve outcomes, and illuminate how they may best achieve this in practice.

Highlights

- 50th anniversary review charts the evolution of corporate and organizational foresight in TF&SC
- Summarizes past 5 decades of foresight applied in corporations, organizations, and institutions
- Highlights key articles and how they have defined and evolved this part of the foresight field
- Provides base for assessing current priorities and future challenges in corporate foresight
- Looks ahead to coming decade, how institutions may use and integrate foresight

Keywords: Corporate foresight; organizational foresight; literature review; strategy; innovation; planning

1 Introduction

In this paper we present and discuss this journal's contribution to the development of corporate and organizational foresight throughout the decades since 1969. Our threefold aim is to find and revisit significant early papers that have enduring relevance to this literature, to show the arc of development of this part the foresight field over time and how this journal has contributed to it, and to postulate where the field goes from here. Our purpose is to identify and illuminate in this journal the contributions that have built up corporate and organizational foresight, and document their key findings and advances, as a base upon which to consid-

er the ways this area of the foresight field may further progress in the coming decade, and therein future-management practices in companies and organizations expanded and improved.

We define corporate and organizational foresight as the application of futures and foresight processes by an organization to advance itself; that is, to fulfill its purpose and achieve success on whatever terms it defines such success. While much knowledge has been produced on how to conduct foresight, less attention has been given to how foresight is integrated with a firm's strategy, planning processes, innovation, and operational activities. Beyond perceiving and making sense of external change, to fully benefit, firms need to integrate this knowledge into their innovations and transitions. This is the focus here. Our framework includes all forms of constituted organizations or institutions: for-profit, non-profit, and wider-purpose institutions. In this regard, the term *corporate* is understood both in its common use, as shorthand for a commercial conglomerate, and with reference to its etymological roots (from Latin: corpus, a body). Therefore, here we are referring to, and have limited ourselves to, where organizational "bodies" use foresight. That is, where foresight is applied "in-house" in pursuit of the organization's agenda, helping it to account for and manage future uncertainty in decision-making. This may be found either where a paper describes an organization's own experience as a case study, or where a paper describes how future methods may be applied to organizations. It is also intended here that in-house may include use of foresight across an organization's sub-units or across a networked organization; that is, wherever an identifiable organization framework is acting for itself. Such action may include use of foresight in a directly commercial sense, to increase the competitive advantage or value-creation within a firm, including supporting the renewal of capabilities when faced with external change, or in the sense of contributing to organizational decision-making and the ability to understand and act successfully within a context of future environmental uncertainty.

In making these clarifications and delimitations, we continue to use the definition of corporate foresight as used in this journal in the 2015 special issue on corporate foresight: "Corporate foresight is identifying, observing and interpreting factors that induce change, determining possible organization-specific implications, and triggering appropriate organizational responses. Corporate foresight involves multiple stakeholders and creates value through providing access to critical resources ahead of competition, preparing the organization

for change, and permitting the organization to steer proactively towards a desired future." (Rohrbeck, Battistella, & Huizingh, 2015).

We have undertaken a systematic literature review to identify the contributions that have made a lasting impact on the journal and the field, which is explained in the methods section that follows below. We subsequently provide a thematic discussion of the contributions of the major papers, organized by decade. We conclude with a view to further challenges in understanding and improving corporate foresight and a view on how these challenges may be met.

2 Research Design and Methodology

We have undertaken a systematic literature review (Booth, Sutton, & Papaioannou, 2016; Tranfield, Denyer, & Smart, 2003). In our research design, our imperative was to reveal for further study the most important and impactful papers in the area of corporate and organizational foresight that have been published in *Technological Forecasting & Social Change* over the past 50 years. In this effort, one of our specific priorities was to create a methodology that would give equal weight and attention to early papers, on the understanding that our purpose here is to recognize the foundational contributions both in themselves and in the way they have opened up the terrain in this part the foresight field.

The article search-and-filtering process is illustrated in Figure 1. The first step was to identify the total population of articles in the journal that have contributed to corporate and organizational foresight. We limited our search in the Web of Science database to this journal and used six keywords and phrases: *"Corporate Foresight," "Strategic Foresight," "Organization," "Organisation," "Firm,"* and *"Planning"*. The search results included 828 articles. We grouped these into five decades: 1969-1979, 1980-1989, 1990-1999, 2000-2009, and 2010-2018. In the second step, we aimed to identify the most influential articles, which we accomplished by selecting the top 15 most highly cited publications from each decade.

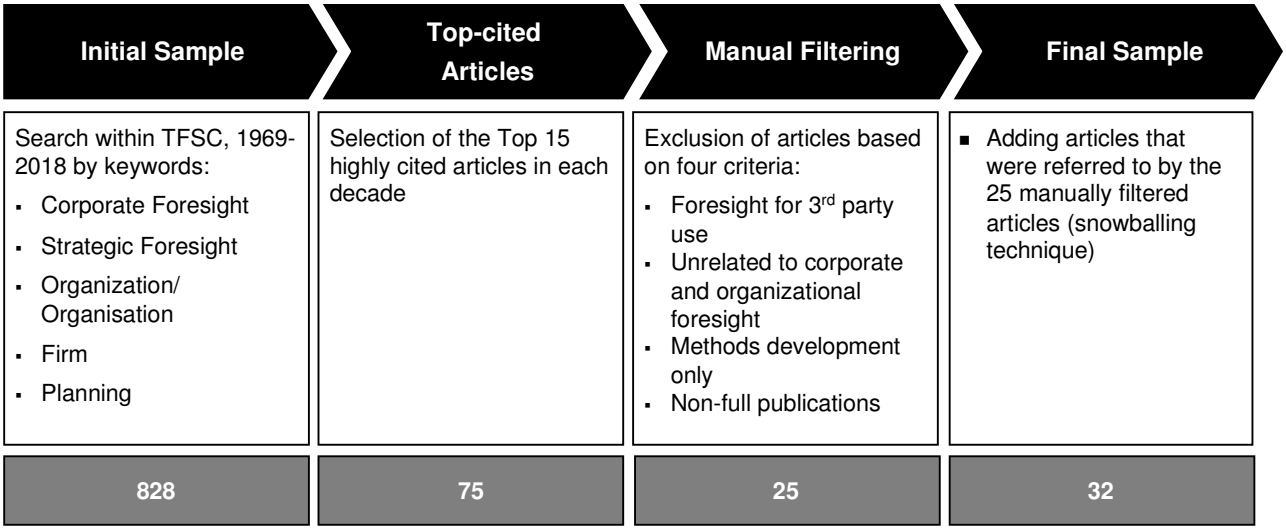

Figure 1: Filtering process of the systematic literature review

In the third step, we manually excluded papers that were not primarily or sufficiently related to the core aim of our study. The manual filtering was informed by implementing a series of four exclusion criteria, as represented in the following table:

Table 1: Filter criteria for manual filtering

Exclusion criteria	Description	No. of exclude articles
Foresight for third-party use	Publications that demonstrate use of foresight techniques at levels beyond the organizations, for example, by use in the development of national policy.	22
Unrelated to corporate and organizational foresight	Publications are not related to the topic area of corporate and organizational foresight, as defined above.	15
Methods development only	Publications that exclusively focus on method development, and which do not discuss the application of this method or methods in an organizational context.	10
Non-full publications	Publications that are not full papers (e.g. notes, comments, or book reviews).	3

Cumulatively, after these three steps, 25 publications remained for closer study. These articles fulfilled our primary criteria, allowing our study to address itself to publications that are (i) closely related to the topic of corporate and organizational foresight; (ii) influential, as judged by citations; and (iii) equally and fairly distributed across the 50 years of the journal's publication history. In the fourth step, we added articles through

backward and forward snowballing, starting from the 25 articles identified in step 3. An overview of the selected publications is provided in Appendix 1.

3 Summary Review

The following section creates visibility regarding the key concerns, methods, and solutions apparent in papers from each decade in the journal in the area of corporate and organizational foresight, as selected by the process above.

3.1 1969-1979

In the 1970s, the most-cited articles regarding the application of foresight to company and organization use wrestle with the question of how technological forecasting can be connected with, and therefore have greater impact on, the organizational decision-making and planning processes. William Swager of the Battelle Memorial Institute, a private science and technology development company, responds in 1972 to the problem of technology forecasting not fulfilling its promise, and a disenchantment and "a growing wave of disillusionment and questioning" in that forecasts have little impact on plans or decision-making (Swager, 1972a). For Swager, the problem is not that forecasts are being poorly done; rather, it is that they are decoupled from the planning process. When technology forecasting is not directly related to the decision-making processes of the organization, "there is no basis for determining what should be forecast, when a forecast must be available in order to be useful, or how much time and effort can be devoted one area of technology compared with another" (Swager, 1972a, p. 87). Swager seeks to redress this disconnect in a 3-paper series (1972-1973) in which *Strategic Planning 1: The Roles of Technological Forecasting* is the first to take steps toward building what he calls a "systematic two-way interaction" (foresight in iterative relationship with planning) throughout the organization. In this, he rests in part on *A Method for Integrating Goals and Technological Forecasts into Planning,* (Cetron, 1970), which details technological forecasts generated by the US Naval Civil Engineering Laboratory, particularly with regard to its internal decision as to which R&D projects to fund. According to Cetron, for a forecast to be genuinely of use, the question "becomes one of allocation of resources

of men, money, and materials," that is, shifting "from the technical specialist to the agency head, the head of research, and the agency planners. The data must be fitted into their overall planning approach if it is to be really useful" (Cetron, 1970, p. 29).

Swager's second paper, *Policy Options* (1972b), introduces the "perspective trees" tool to structure sets of social, economic, political, and technological forecasts that pose threats and present opportunities for management consideration. The point of perspective trees is to transform forecasting from a generic, external process to one that is driven by the needs of a firm's managers and planners. The perspective tree addresses items such as "what forces of change will affect the business" and "what forecasts are needed to define better what (the) possibilities might be." The third paper, *Objective Trees* (Swager, 1973) introduces and describes how another tool, "objective trees," can be used for structuring and clarifying options in decision-making and selecting strategies. Taking a Battelle client as a case of a concrete panel manufacturer interested in organizing an R&D program, Swager demonstrates his objective tree method for starting with intermediate-level management objectives and working backward from them to R&D needs. This technique was partially introduced by Swager in association with William Sheppard, also of Battelle, in 1970, in *Relevance Analysis in Research Planning* (W. J. Sheppard, 1970). Here the authors are concerned with how firms choose the topics of their own R&D projects. Orientation of the research toward the solution of problems or exploitation of opportunities requires, in their terms, attention to the question of "what do we forecast" (as valid R&D terrain) and this question is answered by way of Batelle's internally developed "relevance-tree technique", by which corporate activities; science and technology, and environment (wider market and contextual issues) are narrowed by way of a cross-impact framework.

In *A Cross-Impact Model Applicable to Forecasts for Long-Range Planning* (1973), Wade Blackman seeks to improve on the decision-tree approach to sales forecasting by demonstrating a method based on cross-impact analysis, which can estimate the effects of uncertainty in future sales programs and the effects of program interaction on long-range sales forecasts. In the same year, Blackman in *New Venture Planning – Role of Technological Forecasting* (1973) is similarly absorbed with the relationship between forecasting

and its use, here specifically concerned with the non-connection between forecasting and new-venture planning, or why technology forecasting appears only to have a peripheral impact on new venture decisions (Blackman, 1973). In part, for Blackman, the disconnect between forecasting and venturing that is apparent in most firms is in the ability to overcome by acknowledging that technology considerations often exert less leverage on the success or failure of new product ventures "than do other factors such as market considerations, investment timing, competitive factors... consideration must be given to the interactions between socio-political, economic, ecological, and technological factors which lead to the production of future innovations that will actually use technology, rather than the production of technology as an end in itself" (Blackman, 1973, p. 29). Therefore, it becomes necessary to focus attention on the overall system applicable to the analysis and planning of new ventures, rather than merely on the process of technology production. Technological forecasting needs to evolve into "innovation forecasting."

More than a decade later, Blackman (1986) will extend his argument to the ways in which innovation diffusion models may be built and used to evaluate technological advancements, predict the rate at which new products substitute for old in the market, and thus support decision-making related to the commercialization of technological innovations in new venture planning. At this earlier stage, Blackman offers a model for an integrated new-venture planning system, including indicating the role played by technological forecasting in some but not all parts of it (He refers to the model as specifically oriented to the viewpoint of a firm in the private sector; that is with minor modifications, such as the substitution of benefit-cost concepts for rate-of-return, also applicable to government planning). Blackman's model also emphasizes a recognition that was growing at the time in technology forecasting, apparent also, for example, in (Swager, 1972b), that market factors play "a much more decisive role in the success of new product ventures than do technology factors." (Blackman, 1973, pp. 28-29). Therein technology forecasting is improved by integrating a wider perspective, as evidenced in the new-innovation planning model he advances, where the starting point is the identification of future market needs. After such needs are identified, new product concepts are formulated and designed to fulfill these needs. Their technological characteristics are projected into future time periods corresponding, in Blackman's terms, to the time period projected for the development of the future market need. When projec-

tions are primarily oriented to capability, the exploratory forecasting techniques are of greatest application; following which it becomes important to ensure congruency between the rate of development of market needs and the rate of development of technological capability.

In parallel to the development of organizational foresight in the English-speaking literature and in particular in TFSC, it should be noted that since the mid-1950s, the francophone world has an active research and practice community with the La Prospective school (Berger, de Bourbon-Busset, & Massé, 2008; Coates, Durance, & Godet, 2010). Emerging from the frustration that decision-making frequently remains short-term focused and informed by debates that emphasize the means rather than the ends, Gaston Berger developed a set of principles, a toolbox and a club in which most large French multinational companies were members. The La Prospective school, however, documented their methods and tools and application cases only much later in English-speaking journals (e.g., J. Bootz, Monti, Durance, Pacini, & Chapuy, 2019; Durance & Godet, 2010; Godet & Durance, 2011).

3.2 1980-1989

The 1980s marked the emergence of various papers that respond in an array of ways to new and greater forms of external change and the end of what many retrospectively see as an era of relative post-War certainty that is coming to an end. While the Delphi method is a topic of interest in the journal from the start (e.g., Turoff, 1970), and continues to be regularly discussed (including a special issue in 2011), there are not a significant number of highly cited organizational applications of the method. One exception is Kruus' (1983) *Utilization of Delphi Methods for University Planning*, which provides a retrospective review of a Delphi process undertaken in 1970-1972 by Carleton University in Ottawa, Canada. The form of this particular Delphi study is normative rather than predictive, asking questions such as: should the university (a) try to induce changes in society or (b) avoid involvement in social issues; should it encourage research (a) that is oriented more toward the solution of real problems or (b) toward knowledge for its own sake. It asks such questions of nine participating sub-groups, which we would nowadays call stakeholder groups, rather than seeking "experts" per the conventions of the Delphi method. The lasting interest of the paper is that, with the benefit of looking a decade ahead, Kruus is able to see which stakeholders groups' desired futures were actually

enacted, and that the future direction Carleton University took was more in accordance with the preferences of external stakeholder groups (board of governors, senate, parents, alumni) than those of insiders (students and faculty). Thus, Kruus shows that that this form of Delphi review is useful in revealing where the effective decision-making control of future development of an organization really lies.

In *SIAM: Strategic Impact and Assumptions-Identification Method for Project, Program, and Policy Planning* (1982), George Abonyi presents a method for assessing the "social soundness" of projects, programs, and policies. SIAM initially emerged from a computer-assisted socioeconomic assessment of highway infrastructure plans, and here is presented as a model applicable to a wide range of projects and programs. By way of a SIAM assessment, an organization is better able to assess not the technical and economic viability of a proposed project, but also its strategic viability—particularly with regard to its impact on, and fit with, characteristics of the wider social environment in which it is to be embedded. Via SIAM, the assumptions about the present and future behavior of a variety of stakeholder interests may be anticipated and planned for to better achieve ultimate project success. In another study on related terrain, *Futures-Oriented Municipal Planning* (1985), Abdul Khakee presents a model for a municipal planning system that can adapt itself to different types of sudden change while still taking long-term welfare goals and resource conservation issues into consideration. The model was in the process of implementation in the municipality of Västerås.

Later in the 1980s there appears a well-cited report by the Southern California Edison Company, *Planning for Uncertainty, a Case Study* (Bjorklund, 1988), introduced by the journal's editor in the following way: "The 1980s are witnessing a significant change in corporate planning...there is a shift in focus to planning in the presence of uncertainty. The inevitability of major surprises is accepted and yields a new planning philosophy" (Sioshansi & Bjorklund, 1988, p. 119). This new philosophy is a forced recognition that the post-War era of continuity had ended, therefore planning processes that worked well enough during decades of few surprises were inadequate to companies experiencing more shocks and greater uncertainty. Showing how unforeseen and unforeseeable external events rudely expose the assumptions that underlay its predictive forecasts, the Edison paper challenges and ultimately overturns previous assumptions in corporate planning in the same way the Royal Dutch Shell group planning did (Wack, 1985; 1985b), to which it also refers.

In the study, Edison reviews its corporate five-year plans, undertaken between 1965-1985, and while it asserts that its own technical forecasting is "among the best in industry," the forecasts and plans that they fostered turn out to be worthless. For example, its 1965-1970 plan did not materialize into reality even remotely as envisioned because of the 1965 Northeast blackout (which changed reliability demands) and the passages of the National Environmental Protection Act and the California Environmental Quality Act. The 1970-1975 plan followed a similar path, failing to see anti-nuclear power plant protests, the OPEC oil embargo, and so on. With each 5-year forecast informing a plan that turned out not to even be in the right zip code, let alone hitting its mark, Edison reports how its first response was to double-down with more sophisticated forecasting models, based on more extensive databases. It took some time and further failures to realize that more sophisticated forecasting methods provided no more likelihood of seeing future surprises, therefore "were not the problem's cure" (Sioshansi & Bjorklund, 1988, p. 120). The report details how Edison thus changed course to recognize that unforeseeable events were genuinely unforeseeable, therefore reorienting its planning toward a scenarios approach, and details how it developed 12 scenarios as the basis of a more flexible planning framework for the 1990s.

In *Intelligence-Driven Strategic Planning and Positioning* (1988), John Sutherland also responds to the end of the certainty era, particularly from an American corporation's point of view. Previously, according Sutherland (1988), "the main axis of analytical challenge was for an organization's higher-management to decide what it wanted the future to look like, or what opportunities should be pursued... the contemporary era finds more and more American enterprises engaged in a global competitive context punctuated by the appearance of increasingly ingenious, aggressive and capable adversaries" (p. 302). Sutherland responds by offering a "strategic management technology" solution that transposes procedures used in the professional intelligence and military communities, particularly those grouped under the general heading of Indicator/Warning-Alert (IWA) operations, to corporate management.

Southern California Edison's case study is cited by Mahajan and Wind (1989) in *Market Discontinuities and Strategic Planning: A Research Agenda.* The authors respond to the same existential challenge confronting corporate foresight: forecasting methods based on historical trends and stable relationships that worked in

stable times are unsuccessful at anticipating turning points. Mahajan and Wind (1989) here bluntly state: "the practice and conduct of strategic planning... is futile unless one explicitly considers the nature and role of market discontinuities" (p. 197). For them, a business is based on the assumptions a firm makes regarding its customers, competitors, and market environment (market environment for the authors means: (1) marketing institutions and infrastructure, (2) the sociocultural environment, (3) the economic environment, (4) the political/legal environment, and (5) the technological environment, in other words a concept more typically these days captured by the acronym STEEP OR PESTLE). None of these can be forecast because "a pre-requisite of any form of forecasting, whether judgmental or quantitative is that a pattern or relationship that (continues to) exists concerning the event of interest." (p. 194). However, while holding that a focus on market discontinuities is the critical and missing link in corporate planning for uncertain times, Mahajan and Wind (1989) do not offer a mechanism to illuminate such discontinuities. Mahajan and Wind (1989) do suggest that there is promise in "judgment methods," and call for further research into the use of judgmental scenarios and expert systems. They also cite an extraordinary paper that appears in the journal a few years prior, *Gambling with History, However Unpleasant, Is Normal to the Human Condition"* (Dror, 1986), which forcibly argues that uncertainty is inherent and irreducible, and that "fuzzy gambles, that is, gambles with unknowable and jumpy rules of the game and payoffs," (p. 186) are effectively the best foresight strategy that managers can hope for. Beyond this, in one of many formulations that are decidedly modern and anticipate 21st-century corporate foresight principles, Mahajan and Wind (1989) observe that while market discontinuities tend to upset the strategic fit between a firm and its market environment, such discontinuities can create new opportunities for a firm—which itself therefore might seek to create market discontinuities to achieve competitive advantage.

3.3 1990-1999

Top-cited studies in the journal in the 1990s go in two main directions. There are those that deal with problems of innovation, and the role of foresight in this; and there are those that devolve from the Hamal and Prahalad article and book, *Competing for the Future* (1994), a landmark event in the field. Vijay Mahajan, this time in authorship with Muller (1996), in *Timing, Diffusion, and Substitution of Successive Generations*

of Technological Innovations: The IBM Mainframe Case, builds a model based on a close study of innovation-timing of four successive generations of IBM mainframe computers between 1955 and 1978. It seeks to improve management judgment of the optimal time to introduce a new product, particularly unifying into one model understanding of a technology's processes of diffusion and that of substitution between the various generations of this technology. Improving judgment of timing (rather than direction) of management interventions is considered a key benefit of foresight. Instead, in this case the authors do not call upon foresight methods themselves (although the model is itself partly reliant on sales forecasts), but rather turn to a technical analysis of diffusion and substitution. This analysis includes the substitution implied in cannibalizing the firm's previous offerings, in a quest for a framework that stands without needing direct foresight inputs such as horizon scanning, trend tracking, etc. The a-temporal model they derive suggests that a firm should either introduce a new generation technology as soon as it is available or delay its introduction until the maturity stage of the preceding generation.

Dunphy, Herbig, and Howes, in *The Innovation Funnel* (1996), offer a model of in-company innovation. At the firm level, the paradox they address is that large companies should be able to promote internal innovation better than small companies due to their access to resources and scale efficiencies. This theory is, however, at odds with the facts because of the "mature product trap" and a "sunk-cost" mentality. Their analysis argues that while the size of the firm is relevant, the way the firm is organized and managed truly determines its innovation success, and point to successes that emerge from the creation of small, decentralized organizations within organizations, that are created free of "thought patterns and search habits are highly constrained by the nature of the organization and the technologies already in place." (p. 287) The authors point to companies such as Hewlett Packard and 3M that had formed units that were "entrepreneurial start-ups in almost every respect" (p. 288).

Rias van Wyk, in *Strategic Technology Scanning* (1997), is one of the authors in the latter part of the decade who refers to, and is energized by, Hamel and Prahalad's (1994) attention to corporate foresight. For van Wyk, as welcome as mainstream strategy attention to competing for and managing the future is, the reader "cannot be blamed for expecting to find...detailed recipes for action. Unfortunately, these are not forthcom-

ing" (1997, p. 23). He attempts to fill this gap, particularly bridging between strategy and management of technology in firms, by way of what he calls "strategic technology scanning," which differs from conventional technology scanning in having a greater forward range: It is more concerned with "looking ahead" than "keeping abreast." It does this in part by looking more broadly than routine technology scanning, which, according to van Wyk, is commonly concerned with specialized pre-selected fields as dictated by the business or industry. Maintaining a 360-degree perspective and rising above the detail allows a strategic understanding of technology evolution to emerge. Key to this strategic understanding is being able to identify "landmark technologies," which represent fundamental evolutionary step (analogous to an "indicator species" in ecology). For van Wyk, these are focal points for understanding the external environment, just as "core competencies" have become focal points for understanding the internal organizational capabilities. He further contends that the route to superior strategic foresight for the firm is, therefore, to bring landmark technologies and core competencies together. This is done by way of a matrix framework. Van Wyk demonstrates this with reference to the Danish electronics firm Bang and Olufsen, which reports five competencies: (1) acoustics; (2) image processing; (3) acoustic image integration; (4) system human interface; and (5) system artistic design. The author sets these competencies on the horizontal axis, with landmark technologies such as diamond-thin film, ceramic metal, super magnets, ultrasonic commutation, and laser bonding on one and magnetic levitation, fly-wheel batteries, etc., on the other. Associating important technologies with one or more particular firm competencies opens the door to company management directing future technology insights directly into corporate strategy, and it is argued that this process is also well-tailored to fit conventional procedures for strategic planning.

In another paper that takes inspiration from Hamel and Prahalad (1994), Gausemeier, Fink, and Schlake, in *Scenario Management: An Approach to Develop Future Potentials* (1998), offer an approach to move from scenarios to a firm's strategic management by using the worked example of an ATM manufacturer. The authors see five phases to a scenario project, from formation to use, and Step 5, "scenario transfer," is where scenario formation moves into the realm of creating corporate or business strategies. In their model, companies can base their management planning on either:

(a) one reference scenario ("focused planning") or on

(b) different scenarios (future-robust planning)

and each of these can be carried out in one of three ways, depending on the specific planning situation and the corporate culture of the company (in this way the scenario transfer can be adapted to management culture):

i. Planning-oriented strategy, based on the belief that some environmental changes can be predicted, therefore strategists can take specific actions in anticipation of forthcoming changes
ii. Responsive or preventive strategy, in which the emphasis is on reacting to environmental changes. Uncertainty is accepted, and the aim is to cope with unforeseen change
iii. Proactive strategy, where strategists attempt to shape the environment in a desired direction so that unwanted changes will be less likely to occur.

Du Preez and Pistorius, in *Technological Threat and Opportunity Assessment* (1999), offer a model of organizational foresight whereby scanning signals are cast into a pre-made framework of technological threats and opportunities, and contend that the organizational response level and success will depend on the strength of the signal detected in conjunction with the extent to which the signal has already been identified to represent a threat or opportunity to the organization. In 2000, in a work that is technically in the next decade by our study, but that very much belongs in the extended debate related to scenarios in the 1980s and 1990s, Michel Godet in *The Art of Scenarios and Strategic Planning: Tools and Pitfalls* (2000), brings the notion of *La Prospective* to issues of corporate foresight and planning. In fact, *La Prospective* and its component parts, "preactivity" mastering expected change, and "proactivity" aiming to bring about a desired change, are only fleshed out a decade later in the journal (Durance & Godet, 2010; Godet, 2010). At this stage, the notion is of a normative or goal-led future, where the organization's goal directs its future thinking and use of foresight in strategy formation (in Godet's terms, "where the dream fertilizes reality"). In setting out what the author at this stage calls "strategic prospective," Godet refers to example initiatives of this in action in the French armament department (Direction Générale de l'Armament); the French electrical company (EdF); and the Axa Insurance Group, France. The chief tool involved in achieving strategic prospective is the Matrix of

Cross Impact Multiplications Applied to Classification (MICMAC) method, by which separation of an exploratory phase of "future stakes" from a normative phase is achieved in scenario construction, and therefore provides a base for normative strategic action.

3.4 2000-2009

The 2000s ushers in an era where article citations in *Technology Forecasting & Social Change* ramp up tenfold, primarily due to Internet-based visibility and ease of access (Linstone, 2011), but also in no small part due to the journal's own growing importance. During this decade, technology roadmapping is ubiquitous among highly cited papers related to corporate and organizational foresight, and preeminent among these is *Technology Roadmapping—A Planning Framework for Evolution and Revolution* (Phaal, Farrukh, & Probert, 2004). Technology foresight-related mapping had been around in recognizable form since the 1970s, in use at companies such as Motorola, Phillips, Lockheed Martin, and others in technology-intensive industries, where approaches rested on scanning, communication, and knowledge management techniques. With the arrival of technology roadmapping, this becomes a defined methodology that seeks to structurally integrate technology foresight into the strategy and business planning domains, aligning technology and commercial perspectives. Technology–business integration reflects the increasing importance of technology and technology management in firms' search for a competitive advantage, therefore indicating the importance of its place in the corporate strategic process, particularly in the context of changing market demands, new risks, threats, and evolving industry competitive dynamics.

Phaal et al. (2004) present technology roadmaps as a structured, temporal, graphical way to represent and explore the simultaneous relationships between (evolving) markets, products, and technologies and, within a company, a tool that integrates what is known about these dimensions at all levels of the firm into a framework that informs decision-making. Roadmaps provide a focus for technology forecasting, and horizon scanning more generally, and connect the technology view to strategy, innovation, and operations. In doing this, they establish links and promote communication between technological discussions and company objectives; that is, with business strategy. In concept, technology roadmapping supports strategy and innovation,

at firm, sector, and national levels. Speaking to company use, the paper defines a wide range: product planning, service/capability planning, strategic planning, long-range planning, knowledge asset planning, program planning, process planning, and integration planning. The authors also introduce their own "fast-start" method (a way to rapidly initiate roadmapping in organizations) developed via 20 of their own in-company collaborations, and use the illustrative short case of Domino Printing Sciences, UK, to illustrate this.

Building on this, in *An Architectural Framework for Roadmapping: Towards Visual Strategy,* Phaal and Muller (2009) pay attention to improving roadmap design, showing how to align its structure and process with company objectives. As roadmaps can be formed to apply at different levels of granularity, from components to entire sectors, map design must be configured and sequenced to suit the level that is being addressed. In doing this, the key initial step for Phaal and Muller (2009) is to formally understand the strategic context which, according to the authors, is best done by a small process team, members of which are "perceptive to change and opportunities, 'out-of-the-box' thinkers, visionary by nature" (p. 41). From this it is suggested that the mapping process adds other groups, such as engineers or scientists who investigate the technology, and then groups such as senior management, customers, and other decision-makers. In this way, the roadmap fuses different inputs into a visual, time-based, multilayered chart that enables the various functions and perspectives within an organization to be aligned, and so forms a general-purpose "strategic lens" through which a business' evolution can be viewed.

In *Customization of Technology Roadmaps According to Roadmapping Purposes: Overall Process and Detailed Modules*, Lee and Park (2005) address the issue of customizing roadmaps for different purposes such as forecasting, planning, or administration, or to fit specific needs or accommodate unusual circumstances. Specifically, they propose a modular method for the "mass customization" of roadmaps to accommodate firm-specific managerial needs and environmental conditions. In the basic combination, four types of product roadmaps are suggested: They include the product family map (the entire product platform being produced at the present time), the product planning roadmap (future plans for product introduction in a specific platform or a product family over time), the product driver map (interpreting a product in its market view),

and the product evolution roadmap (the changing features of customer needs). Following the same logic, four types of roadmaps for technology are suggested: the technology portfolio map, the technology prospect roadmap, the technology position map, and the technology trend map. In choosing and interactively using these sub-maps, managers can customize their roadmap requirements to their businesses' situational and strategic context.

In *Roadmapping a Disruptive Technology: A Case Study (The Emerging Microsystems and Top-Down Nanosystems Industry)*, Steven Walsh (2003) orients roadmapping particularly toward industry-disruptive technologies. Observing that most roadmaps focus on sustaining technologies for firms with a mature sales base, and few if any roadmap processes are available for disruptive technologies, Walsh modifies technology roadmapping for an International Industrial Microsystems and Top-Down Nanosystems Roadmap (IIMTDNR) study, which included approximately 400 firms over five continents, which then forms the basis of the generalized model for disruptive technology roadmapping he proposes. His disruptive technology roadmap does not "artificially limit the scope of the technology and market focus of a disruptive technology base" (p. 180). It embraces a wider range of stakeholders, also in a more proactive manner than standard roadmapping efforts: A firm-based disruptive technology roadmap, for example, would be based on the firm's own nascent competencies, and specifically seek to "speed up" disruptive technology emergence and commercialization via the roadmapping process.

In *Technology Roadmapping in Review: A Tool for Making Sustainable New Product Development Decisions*, Petrick and Echols (2004) adopt a technology roadmapping framework to challenge and extend company decision-making about the future that, according to the authors, too often rests on financial or traditional supply chain parameters. Where firms make product development decisions based on, for example, incremental ROI, or are constrained by seeking recovery of sunk costs, they become trapped in short-term technology investment. By contrast, technology roadmaps allow management decisions to be freed up to see and invest in "technological trajectories." The authors report on the company, Honeywell, using digital roadmapping software (Geneva Vision Strategist) to help to coordinate its investments in new technology and prod-

ucts, particularly in collecting together linked technologies, components, subassemblies, and key aspects of a product that come together to create a successful product offering. The software organizes these developments in terms of timing, financial commitment, and technical uncertainty. The company had recently tied its stage-gate innovation management system to the roadmapping process, therein improving sequencing of events and investment decision-making, according to the paper.

3.5 2010-2018

In this decade, corporate and organizational foresight evolves into a discussion about the elements of foresight practices that create strategic advantage. In *An Evaluation Framework for Technology Transfer of New Equipment in High Technology Industry* (2010), Lee et al. provide a framework with which to value technology transfer involved in new equipment purchases in the thin-film transistor liquid-crystal display (TFT-LCD) industry in Taiwan. The key interest from a futures point of view is the selection and demonstration of a "Fuzzy Delphi" method, rather than standard Delphi technique, because the former, according to the authors, can "deal with fuzziness and vagueness in experts' expressions and reduce the number of rounds in facilitating the formation of a group judgment," as shown in application to this task (Lee et al., 2010, p. 136).

In *Corporate Foresight: Its Three Roles in Enhancing the Innovation Capacity of a Firm*, Rohrbeck and Gemünden (2011) observe that foresight studies themselves do not ensure the success of foresight in a corporate context. Therefore, they argue that it is important to view matters from the perspective of the users of the results of such exercises. On such a basis, it is possible to advance the use of foresight to create value and increase the competitiveness of a firm. The paper particularly considers the contribution of foresight to company innovation, and by way of 19 multinational corporate cases, the authors isolate multifold contributions that foresight makes to the innovation, which they organize into three clusters:

- the strategist role, whereby corporate foresight directs innovation activities by creating forward vision, providing strategic guidance, facilitating internal discussions, and consolidating opinions, judging size of opportunities, repositioning portfolios, identifying new business models, and orienting innovation activity toward promising fields;

- the initiator role, in which corporate foresight assists innovation initiatives by identifying new customer needs, technologies, or product concepts. In so doing, it may trigger R&D or in other ways multiply the number of innovation concepts and ideas, so "feeding the front end of the innovation funnel;"
- the opponent role, by which corporate foresight challenges assumptions and worldviews that are not commonly disputed within the company, which often form the basis of legacy projects, therein helping the perception of disruptions that could derail current or proposed innovations.

The role of foresight in company innovation continues as a theme in Rohrbeck and Schwarz's *The Value Contribution of Strategic Foresight: Insights from an Empirical Study of Large European Companies* (2013), where the authors see its use in reducing the level of uncertainty in R&D projects, enhancing the understanding of customer needs, identifying potential customers, enhancing the understanding of the market, and identifying opportunities and threats regarding our product and technology portfolio. Looking beyond innovation, this study explores the potential and empirically observable value creation of strategic foresight activities in 77 large multinational firms, and so builds a framework for understanding foresight's value contributions as a whole (therein also suggesting how firms may increase the likelihood of achieving such contributions.) When assessing the value contribution to strategy, the authors find that, among the firms studied, strategic foresight:

- fosters a conversation about overall strategy; that is, encourages environmental sense-making and strategic conversation, including challenges to mental models, all of which implies organizational learning;
- supports the adjustment of the company when faced with uncertainty, turning even threatening discontinuous change into an opportunity;
- improves the coordination of business objectives, particularly via such frameworks as technology roadmapping, which coordinates corporate and technology strategy entering new business fields, or planning the strategic renewal of business fields;

- creates the ability to adopt alternative perspectives, broadening the scope of perceived alternatives and taking different perspectives in order to make better strategic choices—that is, challenges "bounded rationality," management heuristics, and the tendency of management teams to converge in world view.

Along each of these dimensions, the authors suggest the need to link research on strategic foresight with research in other management disciplines, as part of the quest to increase in the firm's evolutionary fitness (Rohrbeck & Schwarz, 2013).

In *Strategic Foresight in Corporate Organizations*: *Handling the Effect and Response Uncertainty of Technology and Social Drivers of Change* (2010), Vecchiato and Roveda embrace similar terrain by saying that the literature on foresight and future studies focuses on the techniques and practices for analyzing "state uncertainty". That is, Vecchiato and Roveda (2010) describe the likely path of evolution of emerging drivers (rather than) "effect uncertainty," which is the impact of drivers of change on the competitive position of the firm, or "response uncertainty," which is how to take advantage of change drivers. Their field research into specific large companies (Kodak, Nokia, Luxottica, and Starbucks) indicates that, notwithstanding that these firms were able to properly assess the likely evolution of relevant drivers of change in their industry (using roadmaps, scenarios, Delphi, relevance trees, trend-impact analysis, cross-impact analysis, simulation modeling and systems dynamics, and game theory)—that is, overcome state uncertainty—they often failed in handling effect and response uncertainty. The paper seeks to fill this gap, calling on research streams in managerial cognition and cognitive traps and pitfalls, and—in particular—making a distinction between a "sustaining approach" and an "anticipatory approach" in corporate foresight. A sustaining approach conceives the evolution of a business and its industry context as a linear extrapolation of the current situation, therein elucidating strategic questions such as, "How can we adapt the value chain to a driver of change? How can we leverage this driver to improve our products and services, and to enhance the customer needs we traditionally served? How can we embed the driver in the traditional business model, thus capitalizing on traditional resources, processes, and culture?" While such an approach works in linear future situations, it is obviously bound to fail the test of discontinuous or disruptive change. In order to upgrade performance when dealing

with effect and response uncertainty in discontinuous situations, the authors propose that "the driver itself" (driver of state uncertainty) is, rather than the industry structure, prioritized in strategic thinking (this being their anticipatory approach model). This approach prioritizes the discontinuous driver as starting point of a strategic analysis, as the basis for determining what new configuration of the industry value chain best matches these drivers. In this way, successful management of "response uncertainty" is achieved.

This paper is followed by Vecchiato's (2012) *Environmental Uncertainty, Foresight and Strategic Decision Making: An Integrated Study*, which scrutinizes the firms Royal Dutch Shell, Nokia, BASF, and Philips. This work examines both the drivers of change in each firm's industry over the prior two decades and each individual firm's foresight system, which is defined as "the overall methodological and organizational frameworks) through which companies coordinate their foresight efforts and activities" (Vecchiato, 2012, p. 436). The argument turns on the distinction between "complexity" and "dynamism" as the determinant of environmental uncertainty, whereby it is proposed that Shell and BASF faced uncertainty of the complexity type. As a result, they appropriately developed and refined scenario-based management systems in which coping with uncertainty encompassed all the drivers of change and their mutual connections. Such efforts consist of a long and complex process, reflecting the complexity of the business environment: Time horizons are usually 15–20 years or even longer, matching the payback period of these firms' substantial capital investments.

In contrast, the paper argues that Nokia and Philips faced uncertainty of the dynamism variety. As a result, it was appropriate for them to develop different foresight systems that "aim at: i) identifying trends and disruptive drivers of change to strategy formulation; ii) acting as a tool for identifying new business opportunities and driving organizational renewal" (p. 441). In this, managing uncertainty is framed around focus on the impact of selected drivers and how to exploit the new market opportunities they open up. In such companies, the foresight system is, by contrast, quick and flexible, in order to match the pace of change of the environment: time horizons are typically no longer than 5–10 years. As a case in point, the author mentions the Philips "Probes" program, wherein a corporate unit established in the 1990s (Philips Design) experimentally investigated changes in social values as they emerged in customers' attitudes toward the technologies and products to rapidly identify market opportunities or threats.

Facing either determinant of industry uncertainty, complexity or dynamism, the paper sees the corporate foresight as setting the ground for an adaptive learning process whereby "the core benefits of strategic foresight lie in establishing a process of 'planned learning' about the future, which enhances the organization's capabilities to re-act more quickly and more effectively to external opportunities and threats as they arise." (Vecchiato, 2012, p. 445). Along similar lines, but using a quantitative toolkit, Lempert and Groves of the Rand Corporation describe in *Identifying and Evaluating Robust Adaptive Policy Responses to Climate Change for Water Management Agencies in the American West* (2010) how the Metropolitan Water District of Southern California (MWD) developed an adaptive response to climate change and integrated it into its long-range planning processes. Via this case study, the paper develops the argument for adaptive strategies—those explicitly designed to adapt and evolve over time in response to new information—for managing organizations under significant future uncertainty conditions. The analysis demonstrates what the authors call "Robust Decision Making" (RDM), a set of use-simulation models to assess the performance of the agency's plans over thousands of plausible futures, with algorithms to identify futures where plans would fail to adequately perform. This helps decision makers to understand the vulnerabilities of those plans and assess the options for ameliorating these challenges.

Taking issue with corporate decision support based on what the authors call a predict-then-act framework based on either point or probabilistic forecasts, they show that RDM allowed the MWD executives to generate and consider multiple views of the future, which they call "plausible probability distributions," which serves as a way to follow this with "iterative vulnerability-and-response-option analysis." In other words, not only is perception of the future not limited by prediction or probabilistic narrowing, but strategic response also, similarly, remains open. RDM uses a robustness instead of an optimality criterion to assess alternative policies, and where optimality typically leads to pursuit of a single best or highest-ranking option, RDM analyses are designed to reveal a set of reasonable (robust, satisficing) choices that decision makers can choose among. With a set of robust choices in hand, vulnerability-and-response-option analysis considers them against the MWD's goals, and helps managers to iterate between them as circumstances change. While business strategy literature often calls for "flexibility, agility, and adaptivity" as means for prospering in

times of uncertainty, the MWD case demonstrates a practical path to ultimately realizing this in an organization.

4 Looking ahead

In this section, we seek to explore future research avenues in this field, and will organize the discussion around two questions: (1) Which are the most relevant frontiers in advancing organizational foresight practices (inside perspective) and (2) Which are the most relevant contributions that organizational foresight can bring to other areas, such as strategy and innovation (an inside-out perspective).

4.1 Advancing organizational foresight practices (inside perspective)

In recent years, automation with IT tools and artificial intelligence (AI) has allowed firms to access a growing number of relevant insights into the future, and we can expect that trend to continue (Agrawal, Gans, & Goldfarb, 2017; Montes & Goertzel, 2019; Mühlroth & Grottke, 2018). Organizations will be challenged to help their decision makers to deal with the increasing number of insights. It will also open more opportunities for evidence-based judgments. Going forward, it will thus be important to understand what AI has to offer foresight and how to train managers to use these new capabilities, including for overcoming biases in decision-making (Schoemaker & Tetlock, 2017). Understanding the blending of AI-generated and human-delivered insights and their impact on decision-making is an interesting question for case studies on trials in organizations or development of new practices with design science research approaches (Eisenhardt, 2007; Hevner, March, Park, & Ram, 2004).

AI and automation in foresight will also be able to help to shorten the time required in organizations to translate signals into insights and into action, moving toward real-time decision-making (Aengenheyster et al., 2017). This might allow for more integration between different foresight practices, forming the basis for in-organization, continuous foresight and response systems (Heger & Rohrbeck, 2012; Schoemaker, Day, & Snyder, 2013). Here foresight platforms could play an important role, connecting many inter- and intra-organizational actors, leveraging for foresight insights and for defining options for organizational responses

(Raford, 2015; Rohrbeck, Thom, & Arnold, 2015). To which extent decision-making can be developed towards real time is an interesting question for further investigation with case studies. A useful framing could be the theory of anticipatory systems proposed by Robert Rosen and further developed within the context of strategic foresight by Ted Fuller (Fuller, 2017; Rosen, 2012).

Table 2: Future research trajectories: Advancing organizational foresight practices

Research aim	**Suitable methods**	**Articles**
How to design foresight practices that leverage artificial intelligence (AI)	Case studies, design science research	Schoemaker and Tetlock (2017) Mühlroth and Grottke (2018)
How to design foresight platforms as virtual collaborative anticipatory systems	Case studies	Rohrbeck, Thom, and Arnold (2015) Schoemaker, Day, and Snyder (2013)
How to practice and promote inter-organizational strategic foresight	Case studies, theory testing	Roubelat (2000) Wiener, Gattringer, and Strehl (2017)
To which extent is strategic foresight a predictor for superior firm performance and superior strategies	Longitudinal case studies, theory testing	Rohrbeck and Kum (2018) Gavetti and Menon (2016)

Another interesting question is to which extent foresight can be successfully applied across organizations to promote common goals, form new value networks, and tackle societal challenges (Cook, Inayatullah, Burgman, Sutherland, & Wintle, 2014; Lang & Ramírez, 2017). The concept of networked foresight has been described in this journal by Roubelat (2000) and Heger and Boman (2015). More recently the term "open foresight" has been used to describe foresight exercises in which different organizations engage in collective sense-making, with the aim to pursue innovation and business opportunities (e.g., Gattringer, Wiener, & Strehl, 2017; Wiener, 2017; Wiener et al., 2017; Zeng, Koller, & Jahn, 2019). As products, value networks and challenges become more complex, using foresight in a collaborative fashion across organizations will be vital. Understanding practices, governance, cultural prerequisites, and successful criteria of such "open foresight" can be explored through case studies and longitudinal studies.

Ultimately, foresight has also to be about outcome. In the context of organizations, there are various outcome criteria worth investigating. Recently correlation was reported between the maturity of corporate foresight

practices and firm performance (Rohrbeck & Kum, 2018). Similarly, a number of case studies show the ability of foresight practices to inform and promote business development, innovation creation, technology management, and strategic repositioning (Battistella, 2014; Farrington, Henson, & Crews, 2012; Højland & Rohrbeck, 2018; Rohrbeck & Bøe-Lillegraven, 2017; Ruff, 2015). Recently, the strategic management research tradition, particularly behavioral strategy, has become interested in understanding how unique and creative strategies are formed (Gavetti & Porac, 2018). The foresight field would claim to have many practices to contribute to such a task, but we still lack longitudinal evidence that foresight has promoted such "great" (unique, creative, distant from the industry status quo) strategies such as those that Gavetti and Menon (2016), for example, find in the forming of Merrill Lynch, a financial broker. There are also potential mediating factors, such as organizational attention on the future, which could prevent organizational outcomes and would be worth investigating further (Ramírez, Österman, & Grönquist, 2013; Schoemaker, 2018).

4.2 Organizational foresight for strategy, innovation, and transformation (inside-out perspective)

As we show earlier in this paper, TFSC has contributed throughout the decades to understanding how foresight contributes to innovation management, strategic management, and related planning tasks. In the following we discuss ongoing academic discussions in the field of strategy and innovation, to which organizational foresight will be able to contribute.

4.2.1 Strategy

In a literature review covering the years 2000–2014, over 50 articles investigating the link between foresight and strategy were identified (Iden, Methlie, & Christensen, 2017). One of the prominent theoretical frames is the behavioral theory of the firm (BTF). The BTF is built on the observable bounded rationality of decision-makers (Cyert & March, 1963). It is argued that managers can be expected to search for solutions for problems through local experimentation, rather than via a distant and systematic solution search that requires a high cognitive and action-level effort (Gavetti & Levinthal, 2000). From a behavioral strategy perspective, it is thus interesting to explore to which extent foresight can help to overcome the cognitive bounds of decision makers in order to consider more distant solutions and strategies (Gavetti, 2012). A case in point is the

founding of Merrill Lynch, a financial broker whose strategy was built on a theory of merchandizing that was successful in Safeway, a supermarket chain, in which Charles Merrill was CEO, and which he applied in the financial industry. This theory of merchandizing formed the basis of a strategy that was distant to the strategies of all other market participants and which proved to be superior. In this case, the usage of the analogy from a different industry provided the basis for a cognitive leap in the strategizing of Charles Merrill, and subsequently to the introduction of a new, distant strategy that would become the dominant business model in the financial broker industry and displace the traditional business models (Gavetti & Menon, 2016). Following in this line of investigation would involve asking if foresight practices can play the role of the analogy in the case of Merrill Lynch and provide the basis and platform for facilitating the strategic discussion, which subsequently makes a mental leap possible and allows organizations to create distant strategies or what has also been called "great strategies" (Fink, Ghemawat, & Reeves, 2017; Gavetti & Porac, 2018).

Table 3: Future research trajectories: organizational foresight for strategy

Research aim	**Suitable methods**	**Articles**
How can foresight help to overcome bounded rationality of strategists	Longitudinal case studies	Gavetti and Menon (2016) Højland and Rohrbeck (2018)
To which extent can organizational foresight promote the development of "great strategies"	Case studies, panel data	Gavetti and Porac (2018) Fink, Ghemawat, and Reeves (2017)
How and to which extent can organizational foresight contribute to the building of adaptive organizations	Conceptual, case studies	Levinthal (2018) Daft and Weick (1984)
How do organizations enact scanning, sense making, and trigger strategic responses	Longitudinal case studies, conceptual	Lehr et al. (2017) Sarpong et al. (2018) Schwarz et al. (2018)

More recently, David Levinthal (2018) has argued to shift focus from enhancing strategic decision making to designing organizations to act as "*complex, adaptive systems that are more or less capable of achieving satisfactory strategic outcomes*" (p. 7). With that he resonates well with the older conceptualization of Daft and Weick, who proposed that organizations can be seen as interpretation systems (Daft & Weick, 1984). Levinthal argues that it would be important to understand how strategy-making should be performed so that "*boundedly rationally individuals, particularly operating in some collective fashion, may act to enhance the*

performance and survival prospect of an organization" (p. 73). Or, in other words, how they can organize collective sensing, sense-making, and strategic enacting to enhance the future success of the organization. In that respect, organizational foresight has emphasized the importance of continuous environmental scanning activities and focused sense-making exercises that are ideally driven by scenarios and adaptive planning (Beal, 2000; Hambrick, 1982; Rohrbeck, Etingue Kum, Jissink, & Gordon, 2018; van der Heijden, 1996). It has also been emphasized that new and future environments will need different sensors (Winter, 2004) and that sense-making will require re-framing, which is greatly enhanced by using scenarios and defining alternative courses of action, or strategies (Lehr, Lorenz, Willert, & Rohrbeck, 2017; Ramirez & Wilkinson, 2016). In particular, the sense-making needs to be strong enough to build strong narratives that build on reassembling the past, the present, and the future and can guide new courses of action (Sarpong, Eyres, & Batsakis, 2018). To support the organizational adaptability, strategic foresight practices can also complement dynamic models that allow management to anticipate market feedback as competitive actions unfold (Dickson, Farris, & Verbeke, 2004). Associated tools, such as system dynamics models and business wargaming, have gained importance (Kunc & O'Brien, 2017; Schwarz et al., 2018; Sterman, 2001) and merit further study with regard to enhancing the frameworks of bounded rationality.

4.2.2 Innovation, engineering and R&D management

It has been proposed that foresight can contribute to triggering innovation development (the initiator role), enhance the success of innovation development (the opponent role), or allow organizations to increase the future orientation of their innovation project portfolio (the strategist role) (Rank, Unger, & Gemünden, 2015; Rohrbeck & Gemünden, 2011). It also supports opportunity discovery and the development of future use cases or scenarios of ecosystems in which products will be used (De Moor, Saritas, Schuurman, Claeys, & De Marez, 2014) and has been linked to higher innovativeness when applied within innovation development projects (Jissink, Schweitzer, & Rohrbeck, 2018). Foresight has also been documented to help in planning new, complex products and, through roadmapping, to plan the development of new value chains (Sauer, Thielmann, & Isenmann, 2017). With this, it is established that foresight practices, R&D, and innovation

management practices are developing in a synchronized fashion, further emphasizing the important role that foresight often plays for enhancing the innovation capacity of a firm (van der Duin & den Hartigh, 2009).

Table 4: Future research trajectories: organizational foresight for innovation management

Research aim	Suitable methods	Articles
To which extent can organizational foresight promote innovation success	Longitudinal case studies, theory testing	Jissink et al. (2018) Rank et al. (2015)
What are moderating, mediating factors	Theory testing	Bootz (2010)
How can organizational foresight contribute to develop and steer innovation ecosystems	Conceptual, case studies	Tsujimoto et al. (2018) Inoue and Tsujimoto (2018)

Looking forward in terms of this relationship, more recently the innovation management literature has adopted an ecosystem lens by asking how focal firms can plan for, trigger, and leverage other organizations that are part of its innovation ecosystem (Adner & Kapoor, 2010; Tsujimoto et al., 2018). An important role in the emergence of industrial ecosystems is played by sociotechnical imaginaries (Hooge & Le Du, 2016). Such sociotechnical imaginaries have been defined as "one means through which anticipatory discourse and practices are structured, and thus as a mechanism through which futures are designed" (Pickersgill, 2011, p. 28). Organizational foresight can help to collaboratively develop such sociotechnical imaginaries, which are an important prerequisite and catalyst for the creation and promotion of innovation ecosystems (Hooge & Le Du, 2016; Inoue & Tsujimoto, 2018). The imaginaries can then also play an important role to catalyze value co-creation (Aarikka-Stenroos & Ritala, 2017).

5 Conclusion

This study highlights and documents the key contributions to corporate and organizational foresight that have been carried in the pages of *Technology Forecasting & Social Change* over the past 50 years. In compiling this research, the richness and diversity of contributions have become evident to us and we have sought to reflect that in the document summary review section. Our purpose has been to illuminate the con-

tributions over time in a way that gives equal prominence to the early work, for in that work lays interventions that, in some cases, are unsurpassed and, in others, have been foundational for what followed. To achieve this, we have followed a decade-long timeline methodology, but we remain well aware that such a notion of organization by decade is a post-facto convenience. We offer it as the best way to partially organize the material in a journal that has, over the years, been uniquely open to diverse and varied inputs, as the interdisciplinary field of foresight demands. With this limitation, along with the many constraints of selection and prioritization, which inevitably leaves much excellent work "on the cutting room floor," we feel that our literature review process has found and illuminated the major contributions in this area of corporate and organization foresight over five decades. With this in hand, we have turned to the current priorities and future challenges of the field and hope to have provided scholars and practitioners with the necessary frameworks to continue to advance corporate and organizational foresight in the years to come.

6 References

1. Aarikka-Stenroos, L., & Ritala, P. (2017). Network management in the era of ecosystems: Systematic review and management framework. *Industrial Marketing Management*, *67*(August), 23–36. https://doi.org/10.1016/j.indmarman.2017.08.010
2. Abonyi, G. (1982). SIAM: Strategic Impact and Assumptions-Identification Method for project, program, and policy planning. *Technological Forecasting and Social Change*, *22*(1), 31–52. https://doi.org/10.1016/0040-1625(82)90027-0
3. Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, *31*(3), 306–333. https://doi.org/10.1002/smj.821
4. Aengenheyster, S., Cuhls, K., Gerhold, L., Heiskanen-Schüttler, M., Huck, J., & Muszynska, M. (2017). Real-Time Delphi in practice — A comparative analysis of existing software-based tools. *Technological Forecasting and Social Change*, *118*, 15–27. https://doi.org/10.1016/j.techfore.2017.01.023
5. Agrawal, A., Gans, J. S., & Goldfarb, A. (2017). What to Expect From Artificial Intelligence. *MIT Sloan Management Review*, *58*(3), 28–37.
6. Battistella, C. (2014). The organisation of Corporate Foresight: A multiple case study in the telecommunication industry. *Technological Forecasting and Social Change*, *87*(0), 60–79. https://doi.org/10.1016/j.techfore.2013.10.022
7. Beal, R. M. (2000). Competing effectively: Environmental scanning, competitive strategy, and organizational performance in small manufacturing firms. *Journal of Small Business Management*, *38*(1), 27–47.
8. Berger, G., de Bourbon-Busset, J., & Massé, P. (2008). *De la prospective. Textes fondamentaux de la prospective française 1955-1966.* (P. Durance, Ed.). Paris: L'Harmattan.
9. Bjorklund, G. J. (1988). Planning for uncertainty: A case study. *Technological Forecasting and Social Change*, *33*(2), 119–148. https://doi.org/10.1016/0040-1625(88)90077-7

10. Bjorklund, G. J., & Sioshansi, F. (1988). Planning for uncertainty: A case study. *Technological Forecasting and Social Change*, *33*(March), 119–148. https://doi.org/10.1016/0040-1625(88)90077-7
11. Blackman, A. W. (1973). New venture planning: The role of technological forecasting. *Technological Forecasting and Social Change*, *5*(1), 25–49. https://doi.org/10.1016/0040-1625(73)90017-6
12. Blackman, A. W. (1986). The use of innovation diffusion models in new venture planning and evaluation. *Technological Forecasting and Social Change*, *29*(2), 173–181. https://doi.org/10.1016/0040-1625(86)90061-2
13. Booth, A., Sutton, A., & Papaioannou, D. (2016). *SYSTEMATIC APPROACHES TO A SUCCESSFUL LITERATURE REVIEW*. (M. Steele, Ed.) (2.). SAGE Publications.
14. Bootz, J., Monti, R., Durance, P., Pacini, V., & Chapuy, P. (2019). The links between French school of foresight and organizational learning: An assessment of developments in the last ten years. *Technological Forecasting and Social Change*, *140*(April 2017), 92–104. https://doi.org/10.1016/j.techfore.2018.04.007
15. Cetron, M. J. (1970). A method for integrating goals and technological forecasts into planning. *Technological Forecasting and Social Change*, *2*(1), 23–51. https://doi.org/10.1016/0040-1625(70)90005-3
16. Coates, J., Durance, P., & Godet, M. (2010). Strategic Foresight Issue: Introduction. *Technological Forecasting and Social Change*, *77*(9), 1423–1425. https://doi.org/10.1016/j.techfore.2010.08.001
17. Cook, C. N., Inayatullah, S., Burgman, M. A., Sutherland, W. J., & Wintle, B. A. (2014). Strategic foresight: how planning for the unpredictable can improve environmental decision-making. *Trends in Ecology & Evolution*, *29*(9), 531–541. https://doi.org/10.1016/j.tree.2014.07.005
18. Cyert, R., & March, G. (1963). *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice Hall.
19. Daft, R. L., & Weick, K. E. (1984). Toward a Model of Organizations as Interpretation Systems. *Academy of Management Review*, *9*(2), 284–295. https://doi.org/10.5465/AMR.1984.4277657
20. De Moor, K., Saritas, O., Schuurman, D., Claeys, L., & De Marez, L. (2014). Towards Innovation

Foresight: Two empirical case studies on future TV experiences for/by users. *Futures*, *59*(0), 39–49. https://doi.org/http://dx.doi.org/10.1016/j.futures.2014.01.009

21. Dickson, P. R., Farris, P. W., & Verbeke, W. J. M. I. (2004). Dynamic Strategic Thinking. *Journal of the Academy of Marketing Science*, *29*(3), 216–237. https://doi.org/10.1177/03079459994605
22. Dror, Y. (1986). "Gambling with history," however unpleasant, is normal to the human condition. *Technological Forecasting and Social Change*, *29*(1), 76–81. https://doi.org/10.1016/0040-1625(86)90007-7
23. Dunphy, S. M., Herbig, P. R., & Howes, M. E. (1996). The innovation funnel. *Technological Forecasting and Social Change*, *53*(3), 279–292. https://doi.org/10.1016/S0040-1625(96)00098-4
24. Durance, P., & Godet, M. (2010). Scenario building: Uses and abuses. *Technological Forecasting and Social Change*, *77*(9), 1488–1492. https://doi.org/10.1016/j.techfore.2010.06.007
25. Eisenhardt, K. M. (2007). THEORY BUILDING FROM CASES : OPPORTUNITIES AND CHALLENGES. *Academy of Management Journal*, *50*(1), 25–32.
26. Farrington, T., Henson, K., & Crews, C. (2012). Research Foresights: The Use of Strategic Foresight Methods for Ideation and Portfolio Management. *Research-Technology Management*, *55*(2), 26–33. https://doi.org/10.5437/08956308X5502023
27. Fink, T., Ghemawat, P., & Reeves, M. (2017). Searching for Great Strategies. *Strategy Science*, *2*(4), 272–281. https://doi.org/10.1287/stsc.2017.0052
28. Fuller, T. (2017). Anxious relationships: The unmarked futures for post-normal scenarios in anticipatory systems. *Technological Forecasting and Social Change*, *124*, 41–50. https://doi.org/10.1016/j.techfore.2016.07.045
29. Gattringer, R., Wiener, M., & Strehl, F. (2017). The challenge of partner selection in collaborative foresight projects. *Technological Forecasting and Social Change*, *120*, 298–310. https://doi.org/10.1016/j.techfore.2017.01.018
30. Gavetti, G. (2012). PERSPECTIVE—Toward a Behavioral Theory of Strategy. *Organization Science*, *23*(1), 267–285. https://doi.org/10.1287/orsc.1110.0644
31. Gavetti, G., & Levinthal, D. (2000). Looking Forward and Looking Backward: Cognitive and

Experiential Search. *Administrative Science Quarterly*, *45*(1), 113–191. https://doi.org/10.2307/2666981

32. Gavetti, G., & Menon, A. (2016). Evolution Cum Agency: Toward a Model of Strategic Foresight. *Strategy Science*, *1*(3), 207–233. https://doi.org/10.1287/stsc.2016.0018
33. Gavetti, G., & Porac, J. (2018). On the Origin of Great Strategies. *Strategy Science*, *3*(1), 352–365. https://doi.org/10.1287/stsc.2018.0054
34. Godet, M. (2000). The Art of Scenarios and Strategic Planning. *Technological Forecasting and Social Change*, *65*(1), 3–22. https://doi.org/10.1016/S0040-1625(99)00120-1
35. Godet, M. (2010). Future memories. *Technological Forecasting and Social Change*, *77*(9), 1457–1463. https://doi.org/10.1016/j.techfore.2010.06.008
36. Godet, M., & Durance, P. (2011). Strategic Foresight for Corporate and Regional Development. *Strategic Foresight for Corporate and Regional Development*, 17.
37. Hambrick, D. C. (1982). Environmental scanning and organizational strategy. *Strategic Management Journal*, *3*(2), 159–174. https://doi.org/10.1002/smj.4250030207
38. Hamel, G., & Prahalad, C. K. (1994). Competing for the Future. *Harvard Business Review*, *72*(4), 122–128.
39. Heger, T., & Boman, M. (2015). Networked foresight—The case of EIT ICT Labs. *Technological Forecasting and Social Change*, *101*, 147–164. https://doi.org/10.1016/j.techfore.2014.02.002
40. Heger, T., & Rohrbeck, R. (2012). Strategic foresight for collaborative exploration of new business fields. *Technological Forecasting and Social Change*, *79*(5), 819–831. https://doi.org/10.1016/j.techfore.2011.11.003
41. Hevner, March, Park, & Ram. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75. https://doi.org/10.2307/25148625
42. Højland, J., & Rohrbeck, R. (2018). The role of corporate foresight in exploring new markets – evidence from 3 case studies in the BOP markets. *Technology Analysis & Strategic Management*, *30*(6), 734–746. https://doi.org/10.1080/09537325.2017.1337887
43. Hooge, S., & Le Du, L. (2016). Collaborative Organizations for Innovation: A Focus on the

Management of Sociotechnical Imaginaries to Stimulate Industrial Ecosystems. *Creativity and Innovation Management*, *25*(3), 311–330. https://doi.org/10.1111/caim.12179

44. Iden, J., Methlie, L. B., & Christensen, G. E. (2017). The nature of strategic foresight research: A systematic literature review. *Technological Forecasting and Social Change*, *116*(2017), 87–97. https://doi.org/10.1016/j.techfore.2016.11.002
45. Inoue, Y., & Tsujimoto, M. (2018). New market development of platform ecosystems: A case study of the Nintendo Wii. *Technological Forecasting and Social Change*, *136*, 235–253. https://doi.org/10.1016/j.techfore.2017.01.017
46. Jissink, T., Schweitzer, F., & Rohrbeck, R. (2018). Forward-looking search during innovation projects: Under which conditions it impacts innovativeness. *Technovation*, *in press*. https://doi.org/10.1016/j.technovation.2018.07.001
47. Khakee, A. (1985). Futures-oriented municipal planning. *Technological Forecasting and Social Change*, *28*(1), 63–83. https://doi.org/10.1016/0040-1625(85)90073-3
48. Kruus, P. (1983). Utilization of Delphi Methods for University Planning. *Technological Forecasting and Social Change*, *24*(3), 269–275. https://doi.org/10.1016/0040-1625(83)90019-7
49. Kunc, M., & O'Brien, F. A. (2017). Exploring the development of a methodology for scenario use: Combining scenario and resource mapping approaches. *Technological Forecasting and Social Change*, *124*, 150–159. https://doi.org/10.1016/j.techfore.2017.03.018
50. Lang, T., & Ramírez, R. (2017). Building new social capital with scenario planning. *Technological Forecasting and Social Change*, *124*(Supplement C), 51–65. https://doi.org/10.1016/j.techfore.2017.06.011
51. Lee, A. H. I., Wang, W. M., & Lin, T. Y. (2010). An evaluation framework for technology transfer of new equipment in high technology industry. *Technological Forecasting and Social Change*, *77*(1), 135–150. https://doi.org/10.1016/j.techfore.2009.06.002
52. Lee, S., & Park, Y. (2005). Customization of technology roadmaps according to roadmapping purposes: Overall process and detailed modules. *Technological Forecasting and Social Change*, *72*(5), 567–583. https://doi.org/10.1016/j.techfore.2004.11.006

53. Lehr, T., Lorenz, U., Willert, M., & Rohrbeck, R. (2017). Scenario-based strategizing: Advancing the applicability in strategists' teams. *Technological Forecasting and Social Change*, *124*, 214–224. https://doi.org/10.1016/j.techfore.2017.06.026

54. Lempert, R. J., & Groves, D. G. (2010). Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American west. *Technological Forecasting and Social Change*, *77*(6), 960–974. https://doi.org/10.1016/j.techfore.2010.04.007

55. Levinthal, D. A. (2018). From Strategy to Strategic Organization. In M.-S. Augier, C. Fang, & V. Rindova (Eds.), *Advances in Strategic Management: Behavioral Strategy in Perspective* (pp. 71–77). Emerald Group Publishing Limited. https://doi.org/10.1108/S0742-332220180000039005

56. Linstone, H. A. (2011). Passing the Baton: Linstone to Phillips as Editor-in-Chief. *Technological Forecasting and Social Change*, *78*(1), 1–2. https://doi.org/10.1016/j.techfore.2010.09.003

57. Mahajan, V., & Muller, E. (1996). Timing, diffusion, and substitution of successive generations of technological innovations: The IBM mainframe case. *Technological Forecasting and Social Change*, *51*(2), 109–132. https://doi.org/10.1016/0040-1625(95)00225-1

58. Mahajan, V., & Wind, J. (1989). Market discontinuities and strategic planning: A research agenda. *Technological Forecasting and Social Change*, *36*(1–2), 185–199. https://doi.org/10.1016/0040-1625(89)90023-1

59. Montes, G. A., & Goertzel, B. (2019). Distributed, decentralized, and democratized artificial intelligence. *Technological Forecasting and Social Change*, *141*(December 2018), 354–358. https://doi.org/10.1016/j.techfore.2018.11.010

60. Mühlroth, C., & Grottke, M. (2018). A systematic literature review of mining weak signals and trends for corporate foresight. *Journal of Business Economics*, *88*(5), 643–687. https://doi.org/10.1007/s11573-018-0898-4

61. Petrick, I. J., & Echols, A. E. (2004). Technology roadmapping in review: A tool for making sustainable new product development decisions. *Technological Forecasting and Social Change*, *71*(1–2), 81–100. https://doi.org/10.1016/S0040-1625(03)00064-7

62. Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004). Technology roadmapping—A planning

framework for evolution and revolution. *Technological Forecasting and Social Change*, *71*(1–2), 5–26. https://doi.org/10.1016/S0040-1625(03)00072-6

63. Phaal, R., & Muller, G. (2009). An architectural framework for roadmapping: Towards visual strategy. *Technological Forecasting and Social Change*, *76*(1), 39–49. https://doi.org/10.1016/j.techfore.2008.03.018
64. Pickersgill, M. (2011). Connecting neuroscience and law: Anticipatory discourse and the role of sociotechnical imaginaries. *New Genetics and Society*, *30*(1), 27–40. https://doi.org/10.1080/14636778.2011.552298
65. Raford, N. (2015). Online foresight platforms: Evidence for their impact on scenario planning and strategic foresight. *Technological Forecasting and Social Change*, *97*, 65–76. https://doi.org/10.1016/j.techfore.2014.03.008
66. Ramírez, R., Österman, R., & Grönquist, D. (2013). Scenarios and early warnings as dynamic capabilities to frame managerial attention. *Technological Forecasting and Social Change*, *80*(4), 825–838. https://doi.org/http://dx.doi.org/10.1016/j.techfore.2012.10.029
67. Ramirez, R., & Wilkinson, A. (2016). *Strategic Reframing: The Oxford Scenario Planning Approach*. Oxford: Oxford Publishing.
68. Rank, J., Unger, B. N., & Gemünden, H. G. (2015). Preparedness for the future in project portfolio management: The roles of proactiveness, riskiness and willingness to cannibalize. *International Journal of Project Management*, *33*(8), 1730–1743. https://doi.org/10.1016/j.ijproman.2015.08.002
69. Rohrbeck, R., Battistella, C., & Huizingh, E. (2015). Corporate foresight: An emerging field with a rich tradition. *Technological Forecasting and Social Change*, *101*, 1–9. https://doi.org/10.1016/j.techfore.2015.11.002
70. Rohrbeck, R., & Bøe-Lillegraven, S. Corporate Foresight at Cisco: Introduction of the Technology Radar (2017). Retrieved from https://www.thecasecentre.org/main/products/view?id=145875
71. Rohrbeck, R., Etingue Kum, M., Jissink, T., & Gordon, A. V. (2018). *Corporate Foresight Benchmarking Report 2018: How Leading Firms Build a Superior Position in Markets of the Future*. *SSRN Electronic Journal*. Aarhus, Denmark. https://doi.org/10.2139/ssrn.3178562

72. Rohrbeck, R., & Gemünden, H. G. (2011). Corporate foresight: Its three roles in enhancing the innovation capacity of a firm. *Technological Forecasting and Social Change*, *78*(2), 231–243. https://doi.org/10.1016/j.techfore.2010.06.019

73. Rohrbeck, R., & Kum, M. E. (2018). Corporate foresight and its impact on firm performance: A longitudinal analysis. *Technological Forecasting and Social Change*, *129*(4), 105–116. https://doi.org/10.1016/j.techfore.2017.12.013

74. Rohrbeck, R., & Schwarz, J. O. (2013). The value contribution of strategic foresight: Insights from an empirical study of large European companies. *Technological Forecasting and Social Change*, *80*(8), 1593–1606. https://doi.org/10.1016/j.techfore.2013.01.004

75. Rohrbeck, R., Thom, N., & Arnold, H. M. (2015). IT tools for foresight: The integrated insight and response system of Deutsche Telekom Innovation Laboratories. *Technological Forecasting and Social Change*, *97*, 115–126. https://doi.org/10.1016/j.techfore.2013.09.015

76. Rosen, R. (2012). *Anticipatory Systems*. *IFSR international series on systems science and engineering* (Vol. 1). New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-1269-4

77. Roubelat, F. (2000). Scenario Planning as a Networking Process. *Technological Forecasting and Social Change*, *65*(1), 99–112. https://doi.org/10.1016/S0040-1625(99)00125-0

78. Ruff, F. (2015). The advanced role of corporate foresight in innovation and strategic management — Reflections on practical experiences from the automotive industry. *Technological Forecasting and Social Change*, *101*, 37–48. https://doi.org/10.1016/j.techfore.2014.07.013

79. Sarpong, D., Eyres, E., & Batsakis, G. (2018). Narrating the future: A distentive capability approach to strategic foresight. *Technological Forecasting and Social Change*, *140*(June 2018), 105–114. https://doi.org/10.1016/j.techfore.2018.06.034

80. Sauer, A., Thielmann, A., & Isenmann, R. (2017). Modularity in Roadmapping – Integrated foresight of technologies, products, applications, markets and society: The case of "Lithium Ion Battery LIB 2015." *Technological Forecasting and Social Change*, *125*, 321–333. https://doi.org/10.1016/j.techfore.2016.08.017

81. Schoemaker, P. J. H. (2018). Attention and foresight in organizations. *Futures & Foresight Science*, *in press*. https://doi.org/10.1002/ffo2.5

82. Schoemaker, P. J. H., Day, G. S., & Snyder, S. A. (2013). Integrating organizational networks, weak signals, strategic radars and scenario planning. *Technological Forecasting and Social Change*, *80*(4), 815–824. https://doi.org/10.1016/j.techfore.2012.10.020

83. Schoemaker, P. J. H., & Tetlock, P. E. (2017). Building a More Intelligent Enterprise. *MIT Sloan Management Review*, *58*(3), 28–37.

84. Schwarz, J. O., Ram, C., & Rohrbeck, R. (2018). Combining scenario planning and business wargaming to better anticipate future competitive dynamics. *Futures*, *105*, 133–142. https://doi.org/10.1016/j.futures.2018.10.001

85. Sheppard, W. (1970). Relevance Anaysis in Research Planning. *Technological Forecasting & Social Change*.

86. Sheppard, W. J. (1970). Relevance analysis in research planning. *Technological Forecasting*, *1*(4), 371–379. https://doi.org/10.1016/0099-3964(70)90016-5

87. Sioshansi, F. (1988). Planning for Uncertainty: A Case Study. *Technological Forecasting & Social Change*. Retrieved from https://ac.els-cdn.com/0040162588900777/1-s2.0-0040162588900777-main.pdf?_tid=15f031a1-1fe2-4eb1-9f16-66940c38f524&acdnat=1550134096_55baf6e1a94168540720af448cef0518

88. Sterman, J. D. (2001). System dynamics modeling: tools for learning in a complex world. *California Management Review*, *43*(4).

89. Sutherland, J. W. (1988). Intelligence-driven strategic planning and positioning. *Technological Forecasting and Social Change*, *34*(3), 279–303. https://doi.org/10.1016/0040-1625(88)90072-8

90. Swager, W. L. (1972a). Strategic planning I: The roles of technological forecasting. *Technological Forecasting and Social Change*, *4*(1), 85–99. https://doi.org/10.1016/0040-1625(72)90049-2

91. Swager, W. L. (1972b). Strategic planning II: Policy options. *Technological Forecasting and Social Change*, *4*(2), 151–172. https://doi.org/10.1016/0040-1625(72)90012-1

92. Swager, W. L. (1973). Strategic planning III: Objectives and program options. *Technological*

Forecasting and Social Change, *4*(3), 283–300. https://doi.org/10.1016/0040-1625(73)90059-0

93. Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review *, *14*.

94. Tsujimoto, M., Kajikawa, Y., Tomita, J., & Matsumoto, Y. (2018). A review of the ecosystem concept — Towards coherent ecosystem design. *Technological Forecasting and Social Change*, *136*(April 2017), 49–58. https://doi.org/10.1016/j.techfore.2017.06.032

95. Turoff, M. (1970). The design of a policy Delphi. *Technological Forecasting and Social Change*, *2*(2), 149–171. https://doi.org/10.1016/0040-1625(70)90161-7

96. van der Duin, P. A., & den Hartigh, E. (2009). Keeping the balance: Exploring the link of futures research with innovation and strategy processes. *Technology Analysis and Strategic Management*, *21*(3), 333–351. https://doi.org/10.1080/09537320902750673

97. van der Heijden, K. (1996). *Scenarios: The Art of Strategic Conversation*. Chichester: John Wiley & Sons.

98. Van Wyk, R. J. (1997). Strategic technology scanning. *Technological Forecasting and Social Change*, *55*(1), 21–38. https://doi.org/10.1016/S0040-1625(97)83077-6

99. Vecchiato, R. (2012). Environmental uncertainty, foresight and strategic decision making: An integrated study. *Technological Forecasting and Social Change*, *79*(3), 436–447. https://doi.org/10.1016/j.techfore.2011.07.010

100. Vecchiato, R., & Roveda, C. (2010). Strategic foresight in corporate organizations: Handling the effect and response uncertainty of technology and social drivers of change. *Technological Forecasting and Social Change*, *77*(9), 1527–1539. https://doi.org/10.1016/j.techfore.2009.12.003

101. Wack, P. (1985). Scenarios: Shooting the rapids. *Harvard Business Review*, *63*(6), 139–150.

102. Wack, P. (1985). Scenarios: Uncharted waters ahead. *Harvard Business Review*, *63*(5), 73–89. https://doi.org/Article

103. Walsh, S. T. (2004). Roadmapping a disruptive technology: A case study. *Technological Forecasting and Social Change*, *71*(1–2), 161–185. https://doi.org/10.1016/j.techfore.2003.10.003

104. Wiener, M. (2017). Open foresight: The influence of organizational context. *Creativity and*

Innovation Management. https://doi.org/10.1111/caim.12238

105. Wiener, M., Gattringer, R., & Strehl, F. (2017). Participation in inter-organisational collaborative open foresight A matter of culture. *Technology Analysis and Strategic Management*, *0*(0), 1–17. https://doi.org/10.1080/09537325.2017.1376045

106. Winter, S. (2004). Specialised Perception, Selection, and Strategic Surprise: Learning from the Moths and Bees. *Long Range Planning*, *37*(2), 163–169. https://doi.org/10.1016/j.lrp.2004.01.002

107. Zeng, M. A., Koller, H., & Jahn, R. (2019). Open radar groups: The integration of online communities into open foresight processes. *Technological Forecasting and Social Change*, *138*(December 2017), 204–217. https://doi.org/10.1016/j.techfore.2018.08.022

Appendix A

Authors	Title	Type of research[1]		Citations	Brief summary
		E	C		
			2010-2018		
Lempert and Groves (2010)	"Identifying and Evaluating Robust Adaptive Policy Responses to Climate Change for Water Management Agencies in the American West"	x		148	Based on a single case study, the article describes how the Inland Empire Utilities Agency (IEUA) does long-term planning in relation to climate changes.
Rohrbeck and Gemünden (2011)	"Corporate Foresight: Its Three Roles in Enhancing the Innovation Capacity of a Firm"	x		98	Based on 19 case studies, shows how foresight and innovation can be combined. Three different roles that corporate foresight has in relation to the innovation capacity of the firm are identified: (1) Initiator Role, (2) Strategist Role, and (3) Opponent Role.
Lee et al. (2010)	"An Evaluation Framework for Technology Transfer of New Equipment in High Technology Industry"		x	79	Builds a framework that can evaluate technology transfer in companies.
Vecchiato and Roveda (2010)	"Strategic Foresight in Corporate Organizations: Handling the Effect and Response Uncertainty of Technology and Social Drivers of Change"	x		66	"Effect" uncertainty and "response "uncertainty are discussed in relation to firms' competitive positions. The study is based on four case studies on different organizations from different industries.
Rohrbeck and Schwarz (2013)	"The Value Contribution of Strategic Foresight: Insights from An Empirical Study of Large European Companies"	x		63	By analyzing 77 surveys from multinational firms, determines how strategic foresight can deliver value to firms.
Vecchiato (2012)	"Environmental Uncertainty, Foresight and Strategic Decision Making: An Integrated Study"	x		52	Looks at how foresight in firms can be applied to deal with environmental uncertainty by doing four case studies on firms from different industries.
			2000-2009		
Phaal et al. (2004)	"Technology Roadmapping - A Planning Framework for Evolution and Revolution"		x	418	Provides a discussion and description of technology management and technology roadmapping technique. Application to cases is also present.
Godet (2000)	"The Art of Scenarios and Strategic Planning: Tools and Pitfalls"		x	180	Presents how scenario planning can be used in organizations.

[1] Type of research, predominantly empirical (E) or predominantly conceptual (C)

Authors	Title	Type of research[1]	Citations	Brief summary
Walsh (2003)	"Roadmapping a Disruptive Technology: A Case Study - The Emerging Microsystems and Top-down Nanosystems Industry"	x	156	Describes technology roadmapping as a method and how it is used in practice.
Phaal and Muller (2009)	"An Architectural Framework for Roadmapping: Towards Visual Strategy"	x	104	Describes how an organization can design a roadmapping approach to support their strategic planning.
Petrick and Echols (2004)	"Technology Roadmapping in Review: A Tool for Making Sustainable New Product Development Decisions"	x	104	Discussion of how technology roadmapping, supply chain management, and information technology can be combined in firms in their product development efforts.
Lee and Park (2005)	"Customization of Technology Roadmaps According to Roadmapping Purposes: Overall Process and Detailed Modules"	x	102	Describes how technology roadmapping can be customized.
		1990-1999		
Mahajan and Muller (1996)	"Timing, Diffusion, and Substitution of Successive Generations of Technological Innovations: The IBM Mainframe Case"	x	139	Describes a model that organizations can use in relation to technology innovation. An illustration on a case is also presented.
Gausemeier et al. (1998)	"Scenario Management: An Approach to Develop Future Potentials"	x	81	Presents and discusses a scenario management approach and how it can be applied in relation to the development of corporate business strategies.
Van Wyk (1997)	"Strategic Technology Scanning"	x	25	A methodological procedure for "strategic technology scanning" is presented in this article.
Dunphy et al. (1996)	"The Innovation Funnel"	x	20	Introduces "The Innovation Funnel" and how it can be used in relation to the innovation activities in organizations.
Du Preez and Pistorius (1999)	"Technological Threat and Opportunity Assessment"	x	13	Discusses innovation, technological forecasting, and the "threat and opportunity assessment" and identifies innovation in organizations.
		1980-1989		
Mahajan and Wind (1989)	"Market Discontinuities and Strategic Planning: A Research Agenda"	x	6	Focuses on the effect of market discontinuities on strategic planning in firms.
Khakee (1985)	"Futures-oriented Municipal Planning"	x	6	Provides a planning model for municipalities as organizations that focus on futures orientation.

Authors	Title	Type of research[1]	Citations	Brief summary
Sioshansi and Bjorklund (1988)	"Planning for Uncertainty – A Case Study"	x	3	Describes, based on a single case study, how Southern California Edison plans for the future.
Kruus (1983)	"Utilization of Delphi Methods for University Planning"	x	3	Describes how the organization Carleton University applies the Delphi Method, where the organization uses 10 groups that participate in the process of engaging in a Delphi exercise.
Abonyi (1982)	"SIAM – Strategic Impact and Assumptions – Identification Method for Project, Program, and Policy Planning"	x	3	Presents a method called Strategic Impact and Assumptions-Identification Method (SIAM) that firms can apply when they are completing projects.
Sutherland (1988)	"Intelligence-driven Strategic Planning and Positioning"	x	2	Describes the "threat-based planning/positioning process" and thereafter applies it in an organizational context.
Blackman (1986)	"The Use of Innovation Diffusion Models in New Venture Planning and Evaluation"	x	2	Describes an approach for organizations to evaluate new technological ventures.
Dror (1986)	"Gambling with History," However Unpleasant, Is Normal to the Human Condition"	x	1	Discusses issues related to philosophy and policy making.
	1969-1979			
Blackman (1973)	"New Venture Planning – The Role of Technological Forecasting"	x	14	Presents a methodology for new venture planning where technological forecasting is included.
Swager (1972a)	"Strategic Planning I – Roles of Technological Forecasting"	x	8	Asserts that forecasting and planning in organizations are seen as a process and five roles for these are outlined.
Blackman (1973)	"A Cross-Impact Model Applicable to Forecasts for Long-range Planning"	x	6	Develops a method directly related to firms to deal with the uncertainty that firms experience in relation to future sales.
Swager (1972b)	"Strategic Planning II – Policy Options"	x	5	Presents the "perspective trees" tool, which can be used to identify threats and opportunities from the external environment.
Sheppard (1970)	"Relevance Analysis in Research Planning"	x	4	Provides a methodology for how organizations can plan a research program by for example including forecasts.
Swager (1973)	"Strategic Planning III – Objectives and Program Options"	x	3	Presents "objective trees" as a methodological tool that can help, for example, in relation to R&D and marketing programs.
Cetron (1970)	"Method for Integrating Goals and Technological Forecasts into Planning"	x	2	Discusses how technological forecasting can be used in planning.

All the cells under the dotted lines in each decade represent publications that have been manually added through backward snowballing from the Top 15 highly cited articles from each decade.