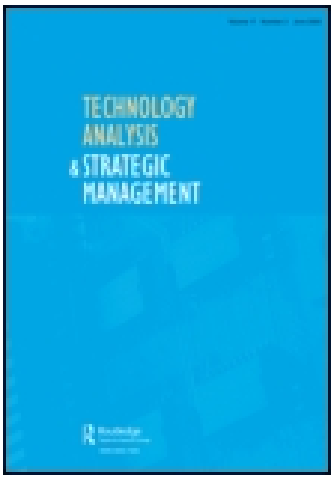

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Strategic foresight: matching environmental uncertainty

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Strategic foresight: matching environmental uncertainty

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This paper explores how strategic decision-makers select and use foresight practices and techniques for handling environmental uncertainty. Our research is based on a multiple-case study of corporate organisations that recently faced major changes in their external environment and increasing turbulence. We expand our understanding of environmental uncertainty by defining the concept of 'boundary uncertainty', which regards the identity of the components of the business (micro) environment. We distinguish between 'continuous' and 'discontinuous' drivers of change and find that they entail different requirements for the design and implementation of strategic foresight actions.

Keywords: environmental uncertainty; strategic foresight; planning; learning; strategic management

Introduction

The strategic management literature (Hofer and Schendel 1978; Miles and Snow 1978; Teece 2007) and the organisation theory literature (Dill 1958; Thompson 1967) have long emphasised the role of the environment as a major source of uncertainty for strategic decision-makers in charge of coping with emerging opportunities and threats.

A broad range of heuristic approaches to coping with uncertainty have been developed in corporate organisations: today, the term 'strategic foresight' is widely used to designate the activities and processes that assist decision-makers in the task of charting the company's future course of action (Coates, Durance, and Godet 2010; Martin 1995; Roveda and Vecchiato 2008). The main goal of strategic foresight is to select promptly drivers of change in the company's outside environment (environmental scanning: see Day and Schoemaker 2006; Hambrick 1982) and to investigate their likely evolution and impact on the organisation (foresight techniques: see Porter et al. 2004).

So far, strategic foresight has uneven success and popularity. On the one hand, scholars have shown that in the last two decades a significant number of leading firms of such diverse sectors as energy, automotive, telecommunications, and information technology have been regularly applying foresight techniques (Daheim and Uerz 2008; Reger 2001; Rollwagen, Hofmann, and

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Schneider 2008; Vecchiato and Roveda 2010a). The wide interest in foresight seems to be confirmed by the growing number of consulting companies and networks in the field.[1] On the other hand, scholars have failed to clearly define the value added of foresight and to provide empirical evidence of its contribution to sustain the advantage of the firm over time. The most relevant example concerning the impact of foresight on the success of the organisation still remains the case of Shell scenarios and its anticipation of the forthcoming 1973 oil crisis (van der Heijden 1996; Wack 1985). In this context, some scepticism arose in the academic community regarding the reliability of foresight efforts and their soundness and appropriateness for supporting strategic decision-making (Bradley MacKay and Costanzo 2009; Grant 2003; Wiltbank et al. 2006). The major evidence of this scepticism may be the fact that today foresight is not specifically addressed by most MBA curricula;[2] furthermore, so far only a limited number of papers on anticipatory studies in corporate organisations have been hosted by leading academic journals.

Scholars and practitioners in the field generally respond to such concern about the reliability of foresight by arguing that its role is not so much to predict the future, but to prepare the firm for the future (van der Heyden et al. 2002; Tsoukas and Shepherd 2004). However, scholars omitted to investigate thoroughly what kind of foresight techniques and practices should a firm adopt in order to match uncertainty in its business environment and thus prepare at its best for the future. The following question remains largely unexplored: *how do managers design their strategic foresight approach in different environments and thus under different conditions of uncertainty*? This is exactly the main question we address in this paper. Its relevance is extremely high because the role of anticipatory actions is a key issue in literature on strategic management (Ansoff 1991; Mintzberg 1990; Wiltbank et al. 2006).

In order to explore the relationships between environmental uncertainty, foresight, and strategic decision-making, we performed a multiple-case study of corporate organisations. In this paper, we focus on BASF in the chemical industry, Daimler in the automotive industry, Philips in the consumer electronics industry, and Siemens in the information and communication industry. These cases are extremely explanatory: on the one hand, the selected firms operated in distinct industries that underwent considerably different (kinds of) drivers of change and conditions of uncertainty. On the other hand, they started long ago to systematically engage in strategic foresight and thus progressively designed and refined their approaches to handling environmental uncertainty.

We start examining the historical evolution and the main drivers of change in each industry of our sample firms since the early 1990s. We then analyse the foresight actions of each firm and the ways these actions fitted its environment. We thus expand our understanding of environmental uncertainty by defining the concept of 'boundary uncertainty', which regards the core identity of the components of the business (micro) environment. We then distinguish between 'continuous' and 'discontinuous' drivers of change and shed light on their implications for foresight and strategic decision-making.

Environmental uncertainty and strategic foresight

Conceptualisation of environmental uncertainty

Early conceptualisations of uncertainty go back to pioneering management scholars such as Knight (1921) and March and Simon (1958), who argued that the business environment of the firm is inherently unstable and this instability creates uncertainty for rationally bounded managers who are not able to fully collect, process, and comprehend information about changes and new events. More specifically, 'environmental uncertainty' arises when managers lack accurate information

about organisations, activities, and events in their external environment; namely, when they are not confident that they can predict what the major changes are or will be (Duncan 1972; Lawrence and Lorsch 1967). Milliken (1987) distinguishes between three types of uncertainty that act together to determine the overall uncertainty faced by strategic decision-makers. The first is 'state' uncertainty and refers to the inability to understand how the components of the environment might change (e.g. in the case of the automotive industry, the driver of change of ecological concern by public policy-makers in Europe: will new laws be enacted in the next 10 years? If so, how strict will these be?). The second is 'effect' uncertainty and refers to managers' inability to predict what the consequences of drivers of change will be on their organisations (e.g. will customers switch from a traditional product – fuel-based car – to an innovative one – hybrid car?). Finally, 'response' uncertainty is associated with attempts to understand what response options are available to the organisation and what the value or utility of each option might be (e.g. should we develop environmentally friendly products?).

Concerning the classification of the different components of the external environment that bring about uncertainty, Dill (1958) makes the distinction between 'general' and 'task' environments. The latter one is made up of elements and sectors with which the firm has direct contact and that directly affect business strategy, day-to-day operations, and goal attainment. According to the organisation theory, the task environment has been initially defined to include the sectors of competitors, suppliers, customers, and regulatory bodies. The strategic management theory expands the concept of task environment by defining the broader concept of business micro environment, which identifies the key forces (sectors) that govern competition in an industry. These forces are competitors, customers, suppliers, potential incomers, substitute products, and providers of complementary products (Porter 1980, 1985).

The general environment refers, instead, to the sectors that affect the firm indirectly; these are the political, economic, ecological, societal, and technological (PEEST) landscapes that surround the business micro environment and today are commonly referred to as the business macro environment (Fahey and Randall 1998).

Strategic foresight: practices and techniques

The challenge of coping with increasing uncertainty encouraged new analytical approaches to decision-making and long-range planning: such approaches are commonly grouped under the label 'strategic foresight' (Coates, Durance, and Godet 2010; Vecchiato and Roveda 2010b). Strategic foresight encompasses two main tasks: the first regards environmental scanning and the detection of new events and drivers of change (Mendonça and Sapio 2009). The second task regards the design and implementation of appropriate techniques for anticipating the likely evolution of drivers of change (state uncertainty), their consequences on the organisation (effect uncertainty), and the most suitable responses (response uncertainty). Roadmaps,[3] scenarios,[4] and strategic options (Dixit and Pindyck 1994) are by far the most popular foresight techniques (Becker 2002; Cuhls and Johnston 2008). But there are many others: for example, Delphi, relevance trees, trend-impact analysis, cross-impact analysis, systems dynamics, and game theory (Glenn 1999; Porter et al. 2004; Roveda et al. 2007).

However, strategic foresight had uneven success. Rigby (2001) found that only 21.5% of North American executives used scenario-planning in 1999, approximately 50% fewer than in 1994. Increasing criticism has pointed to the unreliability of anticipatory studies: while relatively accurate in the short term, forecasting accuracy diminishes in the medium and long terms as political, economic, social, and technological drivers of change interact in novel and unforeseeable ways.

Prominent scholars supported the idea that the best way to handle an uncertain future is to ignore it and emphasised an 'adaptive approach' based on strategic flexibility (Hamel 2000; Mintzberg 1990).

Foresight practitioners and scholars generally respond to such criticism by arguing that the role of foresight and its value added does not lie in predicting the future, but in preparing to deal with the future by means of a learning process that helps the organisation to remain matched to its changing environment (van der Heijden et al. 2002; Tsoukas and Shepherd 2004). In this vein, scholars focused on methodological issues regarding how to *implement* a large number of foresight practices and techniques. However, they generally omitted to clarify *whether* and under *what conditions* of environmental uncertainty a given practice or technique is more appropriate and effective than others. Extant research streams of environmental uncertainty and strategic foresight are not seamlessly aligned. The following issue in particular remains largely unexplored: *how do managers design their strategic foresight approach in different environments and thus under different conditions of uncertainty*?

The main goal of this paper is to address this research question. We aim at expanding our understanding of environmental uncertainty by exploring the different kinds of drivers of change (and the different kinds of uncertainty conditions) a firm might face in its business environment. We thus aim at investigating the suitability and appropriateness of different foresight techniques and practices for coping with such conditions of uncertainty. In this way, we try to enhance the use of foresight by practitioners and to respond, at the same time, to the criticism of (some part of) the academic community: matching the right anticipatory approach with the specific conditions of uncertainty a firm is facing in its business environment is an essential condition in order to enhance the learning process which foresight entails about the future.

Methods and data

The research design is based on an inductive and multiple-case study of a group of selected firms. These firms are BASF, Daimler, Philips, and Siemens.[5] Given the inadequate analysis in the literature and the open-ended nature of our questions, we felt that this methodological approach would be the most useful for theory-building (Eisenhardt and Graebner 2007; Yin 2003). Table 1 provides an overview of our empirical setting.

The cases of these firms are extremely explanatory: on the one hand, throughout the 2000s, BASF, Daimler, Philips, and Siemens operated in different industries that underwent considerably different (kinds of) drivers of change and conditions of uncertainty. On the other hand, they all started long ago to systematically engage in strategic foresight: they put a lot of efforts in terms of both human and financial resources and progressively designed and refined their approaches to handling environmental uncertainty.

Table 1. Overview of case studies.

Firm	Business	Foresight activities started
Philips	Consumer electronics	Early 1990s
BASF	Chemicals	Mid-1990s
Daimler	Automotive	Late 1970s
Siemens	Consumer Products, ICT	Mid-1990s

The unit of analysis was twofold. On the one hand, we examined the historical evolution of each industry of these firms since they started their foresight efforts and in particular throughout the 2000s. On the other hand, we analysed the foresight activities of each firm in relation to uncertainty and drivers of change in its business environment and the use of strategic foresight in decision-making.

Data were collected through the combination of various sources and through an iterative process. First, we collected publicly available data on the industry and the selected firms, including historical annual reports, financial analysts' reports, conference presentations by top managers, and articles and prior studies in the business press and scientific journals. Second, company archives such as internal memos and technical papers supplemented publicly available data. Third, we interviewed a sample of senior and mid-level managers, in particular, the heads of the organisational unit in charge of foresight activities. We also interviewed external consultants who were involved in the foresight process. Finally, we interviewed a sample of leading experts from academia and industry who had extensive knowledge of each company and its industry. Interviews were semi-structured and lasted from 1 h to half a day.

Data analysis was highly iterative and used traditional approaches for inductive research (Eisenhardt 1989; Yin 2003). Analysis began with detailed written accounts and schematic representations of the historical evolution of the industry of each firm. After constructing the case histories, we conducted a within-case analysis, which was the basis for developing early constructs and hypotheses. Cross-case analysis and theory triangulation with different bodies of literature on environmental uncertainty, foresight, and strategic management produced the conceptual framework that we illustrate in the following sections.

Matching strategic foresight with environmental uncertainty: empirical evidence

In this section, we illustrate the main findings of our research. We grouped our sample firms into two clusters on the basis of the similarities in the kinds of drivers of change they faced and the foresight approaches they adopted: the first cluster is made up of BASF and Daimler; the second cluster is made up of Philips and Siemens. On the one hand, BASF and Daimler operated in mature and global industries (chemicals and automotive) where the main drivers of change stemmed from the macro environment; on the other hand, Philips and Siemens operated in fast-paced industries (consumer electronics and information and communication technology (ICT)) which were strongly affected by new technologies and customer needs.

Foresight in mature industries

Environmental uncertainty and foresight approach

The chemical and automotive industries throughout the last decade were typically mature and global industries where trajectories of technologies and customer needs were well established and companies competed for market share at the international level. The boundaries between the micro and macro environments were blurred in these industries; the huge number of drivers of change in the PEEST landscapes, their strong mutual influences, and the slow overall pace of evolution have contributed to high complexity.

The structure of the chemical industry resulted from an as yet uncompleted consolidation process and also from the rise of new competitors in Asia, Middle East, and Eastern Europe that entered the market by producing reliable, good-quality commodities at low cost. Since the 1990s, the demand for chemicals has been characterised by low growth and considerable cyclicality

(which is likely to increase in the near future). Capacity cannot be adjusted easily, so there is a constant danger of overcapacity. The industry has also been increasingly exposed to rising raw material prices, steep rises in energy costs, growing ecological concerns, and stricter environmental rules, while, at the same time, the rapid development of ICT tools made the market far more transparent and increased the pressure to optimise commodity production.

Many of these features may be easily found in the automotive industry as well, where the recent financial and economic crisis has exacerbated structural problems of global overcapacity.

In such a context, BASF's strategic foresight approach to investigating the evolution, impact, and response options to macro drivers of change (i.e. for coping with state, effect, and response uncertainty) was framed around scenarios. These were built via a top-down process that started at corporate level, by first taking into account the global economy and the overall chemical industry and subsequently elaborating regional and business scenarios in relation to each specific geographic and business area of the firm. Strategic foresight activities at BASF started in the mid-1990s, when the company realised that the chemical industry was going through major structural changes which made accurate and reliable predictions extremely difficult. It therefore decided to use scenarios as its basic methodology for tackling the challenge of investigating the major driving forces and how they might affect the organisation. Macro forces and their likely evolution are described in BASF 'Global Economy Scenarios', where econometric models elaborate basic data in both qualitative and quantitative terms, and likely GDP growth rates are depicted. All the main customer industries of the company (the manufacturing, agriculture, and construction industries) are included, so that conclusions can be drawn about the resulting demand for chemical products and about the overall industry's internal adaptation, in terms of consolidation, mergers and acquisitions, divestments, etc. Subsequent foresight activities address specific regions (the EU, the USA, and Asia) and countries, by breaking down global scenarios into the firm's main sectors and business areas, that is, chemicals, plastics, performance products, agriculture and nutrition products, and oil and gas. These country and business scenarios derive from a more focused analysis, which considers a larger set of framework variables, such as national regulations or exchange rates, and market issues, such as moves by suppliers and established competitors. The time frame is usually 10–15 years for Global Scenarios, but much shorter for sector and business scenarios.

Daimler has also developed a scenario-based system which focuses on the evolution, impact, and response options to drivers of change (Ruff 2006). Such system aims at encompassing and integrating analyses of future changes in the macro environment into market and product issues. Foresight activities address major trends and forces in the political, economic, infrastructural, social, and cultural landscapes which are likely to shape the future of the transport and mobility business and are carried out at a global level or for a specific region over a 10–15-year perspective. At the market level, more focused scenarios are built and take into account the likely competitive moves of rivals and changes in society, consumers' behaviour, and mobility (i.e. cultural conditions, lifestyles, urban life trends, etc.). These scenarios aim to figure out the likely evolution of main business segments of the firm, so to derive future demand projections for passenger cars, vans, and trucks in different geographic areas and countries.

Foresight and decision-making

Decision-makers at BASF seamlessly embedded foresight activities in the strategy formulation process. Scenarios are usually combined with the formulation and evaluation of strategic options, as they are seen as providing information inputs essential for assessing the profitability of current and potential business areas and for assessing investment (and divestment) decisions for

expanding (or downsizing) operations in the main business and geographic areas of the firm. A notable corporate-level example has been the decision to withdraw from the pharmaceutical industry. Notwithstanding the positive outlook of both demography and demand growth, the foresight analysis highlighted increasing operating costs due to social and political concerns, as well as the likelihood of strong pressure to reduce prices to consumers, seen as likely to undermine general profitability levels. Future pharmaceutical R&D activities also promised to require huge investments, so implying that resources had to be shifted from other, more attractive, business areas. At business and operational levels, strategic foresight supports the definition of target features for enhancing products and services, as macro trends in the global environment are translated down into priorities for action in specific innovation fields. For instance, in the performance products and construction sectors, macro trends of increasing pressure on cost-saving, environmental concerns, and growing urbanisation have led the firm to boost product development in the thermal insulation, glazing, and heat storage fields.

Similarly, scenarios capture complexity through a multi-level hierarchy at Daimler, which progressively links macro drivers of change with specific management objectives and business issues. The outputs from foresight activities provide a wide basis of information which explores long- and medium-term changes in customers' needs and lifestyles, by rooting them in an understanding of the long-term dynamics of technologies, economics, society, and politics. A relevant example has been the development of the 'Smart' car concept. A scenario-building process was carried out with a special focus on changing mobility patterns in urban lifestyles, and one of the most relevant ideas that fitted the scenarios was for a small, trendy two-seater car. The foresight process then investigated the technical and economic feasibility of the concept, which the top management decided to endorse by establishing a new brand and a subsidiary start-up.

Foresight in fast-paced industries

Environmental uncertainty and foresight approach

The consumer electronics and ICT industries, that is, the context of our case firms Philips and Siemens, throughout the 2000s were rather dynamic. The growing pace of technology developments and the continuous emergence of disruptive changes in customer needs have together contributed to greatly increased dynamism in these industries and for these firms.

Let us consider the case of consumer electronics: in the display and large-screen TV segment, in the last decade, there have been some major market launches of such new technologies as liquid crystal display, plasma display panel, surface-conduction electron-emitter display, organic electroluminescent, and liquid-crystal-on-silicon. New applications and consumption opportunities have become ever more widespread – Internet, digital camera and camera phones, pay-TV, sport events, home cinema and film (video) on demand, game consoles, and 3D and interactive games, each requiring specific product features in terms of resolution graphics, colour brightness, and image definition.

The same considerations can be easily extended to the broader ICT ecosystem where Siemens operates, as major changes in technologies and ensuing customer demand are again continuously scrambling the boundaries of the business.

In such a context, strategic foresight efforts at Philips aimed essentially at detecting new trends in society, technologies, and customer needs in a timely manner and at figuring out their implications for the activities of the value chain and the rise of new players. A corporate unit (Philips Design) established in the 1990s delivers innovative design concepts and services for the company main businesses. Within Philips Design, the 'Trends and Strategy' team has been devoted to the

investigation of three axes – 'Society', 'Culture', and 'People', with a focus on discontinuities in social values and the expressions of these values as they emerge in customers' attitudes towards the technologies and products they use in their everyday lives. A specific initiative – the 'Probes Program' – has been established recently as a long-run (10-year time horizon) research project intended to present 'provocations' about new lifestyle patterns, which are published or exhibited to stimulate debate and criticism within the organisation (a recent example concerned clothing and electronic tattoos that reveal the emotional state of their wearers). Philips' foresight activities included as well Philips Research – the group's corporate R&D unit – which regularly develops technology roadmaps concerning the group main business sectors.

These different pieces of insight are finally matched through an interactive process that brings the social researchers from Philips Design and the technologists from Philips Research together with the business managers from all the product divisions of the company. Insights about socio-cultural trends are exchanged and made coherent with those about technologies and markets, to provide a comprehensive vision of the future evolution of the firm business environment, in a process that guarantees that all view points (people, technology, and business) are taken into account. Foresight activities usually cover a 10-year time horizon, while emerging trend investigations are scheduled yearly to fit in with the annual strategy calendar.

As with Philips, foresight efforts at Siemens aim at identifying strong discontinuities and disruptions in markets and technologies so that they can be acted upon quickly. Foresight activities are carried out by the Corporate Technology unit, where a specific research unit (an 'Innovation Field') has been established for each of the company business segments. The main task of each Innovation Field is to elaborate a 'Picture of the Future' for its target segment, which summarises the evolution of changes in society, lifestyle, and customer needs in terms of both markets and technologies. In the case of the consumer products and ICT businesses, the time horizon is 5 years.

Foresight and decision-making

The main goal of strategic foresight at Philips is to drive the renewal of the organisation by figuring out how to exploit the new market opportunities enabled by emerging technologies or in response to changing customer needs. Since the late 1990s, foresight activities have played a key role in re-defining the company mission, as it focused its value proposition on the 'Sense and Simplicity' concept. In this context, Philips Design and Philips Research have jointly developed the 'Ambient Intelligence' vision, which means an 'intelligent home environment' that utilises a wide range of interconnected and embedded digital devices to make the environment sensitive, adaptive, and responsive to the presence of people. By following this vision, Philips has built its core technological competencies around displays, connectivity, and storage and started to develop and to experiment with innovative product concepts in all its business divisions. A notable example is the Ambilight concept (Ambient Lighting Technology), which aimed at enhancing the home cinema experience by generating lighting effects around the TV set that match the video content, so enabling customers to enjoy a 'larger' virtual screen and thus a more immersive viewing experience.

At Siemens, too, foresight activities go beyond identifying emerging changes in technology and customer needs to encompass the exploitation of the new market opportunities inherent in such changes. Initially, one of the company business groups is targeted as the 'buyer' for a specific market opportunity, and if an innovative idea does not 'fit' with an existing business group, it is allocated to the 'Siemens Technology Accelerator' (part of the Corporate Technology

division), which fosters venture activities within the company and provides financial support to new subsidiary companies and start-ups. Most business groups also have their own venture activity groups, which cooperate in the experimentation and development of innovative ideas, new product concepts, and prototypes.

A model for uncertainty and strategic foresight

In the prior sections, we sketched the strategic foresight approaches that emerged from our data through which major companies of different industries coped with increasing environmental uncertainty. More generally, our findings offer the broad outline of a conceptual framework regarding how decision-makers match strategic foresight with environmental uncertainty. All the firms of our sample were able to detect promptly the key drivers of change in their business. However, the different nature of these drivers prompted them to design and implement very different foresight approaches.

So far, scholars in strategic management have left unexplored a key issue of environmental change: this regards the impact of drivers of change on the identity of the main activities of the value chain and the main components of the business (micro) environment, that is, rivals, suppliers, customers, substitute products, and potential entrants. We define this issue 'boundary uncertainty': it is the difficulty to figure out who the main players and what the main activities of the value chain will be.

The chemical and automotive businesses, on the one hand, and the consumer electronics and ICT businesses, on the other hand, are well suited to illustrate what types of uncertainty a firm may face in its external environment and thus to shed light on the concept of 'boundary uncertainty'. Let us consider the chemical and automotive industries first. The key drivers of change – for example, rise of new rivals from emerging countries and financial crisis – had relevant consequences on the evolution of the main components of the business (micro) environment and thus on the organisation. In any case, these drivers of change did not affect either the identity of these components or the identity of the main activities of value chain of the chemical or the automotive business.[6] Over the last two decades, BASF and Daimler could clearly know in advance who were (i) competitors (i.e. in case of Daimler, other major carmakers and historical rivals such as BMW or new major companies from newly industrialised countries); (ii) suppliers (e.g. tyre-makers and providers of components); (iii) customers (firms and citizens of the most industrialised countries and the emerging ones); and (iv) providers of complementary products (fuel from oil majors). Daimler's managers could be quite confident as well of the main activities of the value chain – for example, assembly of components and production and distribution of cars – and the main markets – industrialised and emerging countries. However, what Daimler (and BASF) could not know in the face of the main drivers of change affecting its industries was how these drivers could evolve (e.g. the length and strength of the financial crisis: state uncertainty), how they could affect the industry structure and the competitive position of the firm (e.g. the decrease of global demand: effect uncertainty), and what responses it could adopt (e.g. postponement of the launch of new models: response uncertainty). Operating in the chemical and automotive businesses could be compared with a person playing a game of cards, who from the beginning has full awareness about the rules of the game and the cards in the pack (i.e. boundaries of the business – identity of the key components of the industry). What the player does not know is which cards he/she will be dealt and what cards will be put on the table (i.e. state, effect, and response uncertainty – evolution of the key components of the industry, effect on the organisation, and available response options).

On the other hand, drivers of change in the consumer electronics business of Philips (or the broader ICT business in the case of Siemens) affected the identity of the main components of the micro environment itself and thus brought about 'boundary' uncertainty. Let us consider in particular such a driver of change as the convergence of multimedia technologies: digital imaging, digital music, games, and high-speed Internet access have definitely enabled more and more functions and services to be used on a TV set (e.g. Internet services such as video on demand) and the rise of completely new kinds of players (e.g. Google and its YouTube web portal). Investigating such changes in technology and customer needs requires not only the anticipation of their likely evolution, but, most of all, an answer to the following questions: what are the new kinds of products and services that customers want? What are the new kinds of benefits they seek? What are the main activities of the value chain? Who is in the business? How can a firm create and capture value? By using the previous analogy of a card game, operating in the consumer electronic business in the 2000s could be compared to the case of a player who still has to learn both the rules of the game and what the cards in the pack are.

Building on the concept of boundary uncertainty, we distinguish between two main types of drivers of change. The first is 'continuous' drivers of change that support and enhance the traditional identity of the main components of the business micro environment, leading to incremental developments in the value chain, products, and services. Continuous drivers of change typically affect mature and global industries where trajectories of technologies and customer needs are well established and stem from the macro environment (PEEST landscapes) which surrounds the industry.[7]

The second category is 'discontinuous' drivers of change that bring about boundary uncertainty, by leading to completely new kinds of products, players, and activities of the value chain. Discontinuous drivers of change are typically disruptive technologies (Christensen 1997) and new customer needs stemming from emerging or growing industries.

Discontinuous and continuous drivers of change entail very different and peculiar implications for strategic foresight and the tools and practices to be used for handling uncertainty. Let us consider the case of continuous drivers of change and the chemical and automotive industries first. Managers at BASF and Daimler could be quite confident about the key decisions they would have to make in the next 20 years or even more, such as what should be the price of our premium products? In this context, traditional techniques such as 'top-down' scenarios (e.g. deductive scenarios starting with two key dimensions: see Schwartz 1991) could be used *directly* for handling state, effect, and response uncertainty. First, these techniques allowed managers to think about the alternative evolutions of drivers of change (state uncertainty) in an organic and systematic way. Second, they allowed managers to *exploit* effectively what they already knew (and needed to know) about the boundaries of their business. Given their prior experience in the chemical and automotive industries, they were able to directly address uncertainty regarding the evolution of the main components of the business and the impact on the organisation (effect uncertainty) and the best options for coping with these drivers (response uncertainty). As the former head of the scenario unit of BASF pointed out to us:

> In the chemical industry, techniques like scenarios were valuable because they helped managers focus on emerging forces of change. Scenarios provided an organic framework for thinking about how these forces could develop in the next 10 or 20 years. At the same time, by exploiting what we already knew about rivals, suppliers and customers thanks to our long experience of the chemical business, we engaged in anticipating the likely structure of the industry and our competitive position – as these could be affected by alternative paths of evolution of drivers of change.

On the other hand, as they were facing *discontinuous* drivers of change, managers at Philips and Siemens had to address the crucial task of identifying the new boundaries of their business. In this context, the key decisions themselves to be tackled by the organisation for future growth were not clear. For instance, in the case of a completely new kind of products such as video on demand: what could be the price? Who is involved in the value chain? In the face of *boundary* uncertainty, it is simply not sensible to use techniques such as scenarios or roadmaps. Instead, environmental scanning efforts and, most of all, explorative actions (e.g. new concepts of product and service, prototypes, commercialisation in target market niches, venture initiatives, and start-ups) serve exactly as a learning process which help managers to figure out the (new) identity of the main components of the business micro environment and the new activities (and products and services) of the value chain. A senior manager of Philips emphasised

> In our business foresight must address an essential prerequisite before using traditional techniques like scenarios: foresight must help decision makers realize the implications of new technologies and customer needs for the value chain, the products we have to provide and the new players who are entering the business.

Only after that boundary uncertainty has been solved and decision-makers have gained a sound grasp of the main components of their industry, they might start using traditional foresight techniques (e.g. roadmaps in the case of Philips) in order to deepen the investigation of state uncertainty (e.g. evolution of demand for new Internet-based services on TV), effect uncertainty (e.g. role of new Internet service providers), and response uncertainty (e.g. partnership with Internet service providers) of 'discontinuous' drivers of change.

Discussion

Our work relates to several fields of research in strategy and organisation. First, we define the concepts of 'boundary' uncertainty and 'continuous' and 'discontinuous' drivers of change and we thus improve our understanding of the different kinds of uncertainty a firm may face in its business environment. Second, we provide empirical evidence on the ways major companies designed their strategic foresight approaches to handling uncertainty and supporting long-range planning (Cassingena Harper et al. 2008; Da Costa et al. 2008). We argue that boundary uncertainty is something different from state, effect, and response uncertainty, which so far have been the main focus of strategic scholars (Milliken 1987). Boundary uncertainty entails strong implications for foresight efforts: our findings suggest that decision-makers facing discontinuous drivers of change and boundary uncertainty are more likely to focus their predictive efforts on environmental scanning and explorative actions (e.g. venture initiatives and start-ups) in order to identify the new components of the industry (see, for instance, Mendonça and Sapio 2009). The definition of the boundaries of the business serves exactly to fix the key decisions for future growth, which is in turn a condition *sine qua non* for starting to profitably use traditional foresight techniques. Decision-makers facing continuous drivers of change – or discontinuous drivers of which they have already solved boundary uncertainty – might eventually exploit scenarios or roadmaps in order to figure out the evolution, effect, and response options to environmental changes, that is, to eventually address state, effect, and response uncertainty.

Discontinuous drivers of change typically stem from technology-driven industries which are at the initial stage of their life cycle. However, mature industries might also be affected by technological discontinuities bringing about major shifts in the boundaries of the business. That might

be the case in the medium/long-term future of the automotive industry itself, if new technological paradigms such as electric of hydrogen car will be established. Firms operating in mature industries have to rely as well on environmental scanning and explorative actions to look for likely technological discontinuities and major shifts in customer needs, even if such events are quite infrequent – and thereby the emphasis on such challenges (and boundary uncertainty) is quite inferior.

Conclusions

In this paper, we try to enhance the academic standing of foresight and its use by practitioners: we believe that matching the right foresight approach with the specific kind of uncertainty faced by a firm is an essential condition in order to foster and nurture the learning process about the future which previous scholars have suggested as the main contribution of foresight to strategic decision-making (van der Hejden et al. 2002; Tsoukas and Shepherd 2004).

Data collection and data analyses were designed in order to improve the construct and internal validity of our conceptual framework. However, much additional research must be done for improving and expanding this conceptual framework through the study of environmental uncertainty and foresight activities in other industries and firms. 'Boundary' uncertainty in particular offers interesting avenues for further investigation. Our arguments suggest that a crucial issue is the ability to distinguish continuous drivers of change from discontinuous ones. Future research efforts can build on literature on innovation and managerial cognition (Tripsas and Gavetti 2000) for investigating how to identify discontinuous drivers and how to renew managerial beliefs about the boundaries of their business.

Notes

1. Relevant examples are GBN (Global Business Network) in the USA and EIRMA (European Industrial Research Management Association) in the European Union.
2. A significant number of managers of the firms we studied pointed out that they had great difficulty in finding and recruiting the foresight skills they required among MBA and PhD graduates.
3. Roadmaps consist of representations of interconnected nodes of major changes and events in some selected fields of the external environment, such as science, technology, and markets. The links connecting the nodes are the roadmaps themselves, illustrating the temporal and causal relationships between nodes (Kostoff and Schaller 2001).
4. Scenarios are focused descriptions of fundamentally different futures presented in a coherent script-like or narrative fashion. As such, scenarios are not projections, predictions, or preferences, but rather credible and coherent stories that describe different paths leading to alternative futures (Fahey and Randall 1998; Schwartz 1991).
5. Siemens is a conglomerate company which operates in a wide range of different businesses (e.g. automation, building, energy, health, and mobility). In this paper, we focus on its operations in the information and communication sectors (ICT – consumer electronics, information and communication solutions and services).
6. It is worth stressing the difference between 'continuous' and 'discontinuous' drivers of change, on the one hand, and 'wild cards', on the other hand. Wild cards are low-probability, high-impact events (Mendonça et al. 2004). Continuous and discontinuous drivers might have either low or high probability and either high impact or low impact: what matters (compared with wild cards) is the nature of their impact on the boundaries of the business.
7. Of course, we do not mean that mature industries might not be affected by 'discontinuous' drivers of change: a new technological paradigm might be established in mature industries as well, bringing the life cycle to the initial stages and bringing about major shifts in the boundaries of the business. What we mean is that, in the last two decades, the automotive and chemical industries were not affected by such 'discontinuous' drivers of change and, more generally, that these drivers are quite infrequent in mature industries.

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