9. Using technology-oriented scenario analysis for innovation research

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9.1 TECHNOLOGY AND SERVICE INNOVATION INEXTRICABLE LINK

Change is the law of life and those who look only to the past or present are certain to miss the future
(J. F. Kennedy, 1963)

Advancements in technology and service innovation have always been intertwined, with service always relying on technology as either an operational resource (Gallouj and Weinstein, 1997; Argyres, 1999) or a core service innovation dimension (Dewett and Jones, 2001). In both applications the strategic adoption of new technologies has always been considered an advantage (Gago and Rubalcaba, 2007). Its speedy evolution, however, has also transformed technology into an innovation challenge, created by the need for faster innovation cycles, and the constant threat of the loss of competitive advantage to other businesses better equipped to foresee, create, adopt, and adapt to this technological evolution and its attendant cycles. This chapter argues that any service innovation-oriented business strategy should take advantage of a number of existing methodological tools derived from the general area of innovation research. The chapter focuses on one such method, *technology-oriented scenario analysis*, and presents a combined theoretical and methodological model that describes how contemporary methods based on "future-oriented technology analysis" (FTA)[1] (Cagnin et al., 2008) can help to foresee these technological evolutions and prepare in time for their possible development and strategic adoption and integration. Scenario analysis is a common and normally integrated methodological approach used in many, if not most, business practices (Diffenbach, 1983). Technology-oriented scenario analysis shares some of its principles with FTA, but in the specialized application described in this chapter is based on a specific set of theoretical assumptions, subjects, data, and analytical approaches that set technology and future technologies' forecast and foresight at center stage. The chapter gives an overview of the theoretical and methodological rationale that informs future-oriented technology analyses and develops a general model that is then applied to service innovation.

The ongoing interrelation between technology and services has been strongly cemented by the development of new Information Technologies (Argyres, 1999; Dewett and Jones, 2001; Bygstad and Lanestedt, 2009; Gago and Rubalcaba, 2007). IT and associated applications have fundamentally transformed established service practices and their old business models. The IT-fueled service evolution started in retailing with new e-service providers such as Amazon and eBay and it evolved with the likes of PayPal in banking, Skype in communication, Wikipedia in education, Uber in transportation, and Airbnb in tourism. It continued with countless other platforms and applications that have quickly transformed service innovation into an imperative, even for business practices once mostly dominated by product development (consumer electronics, automotive and transportation, consumer goods, housing, etc.). In general it can be argued that there is no business or institutional practice or business model that has not been touched or affected by contemporary evolutions in IT and the increasing demand for service and support now associated with any of them. There is also very little chance of this process ending soon, with most areas of life moving towards a greater level of digital interconnectedness.

This well-known shift has generated a more sustained expectation for management to increasingly embed strategies of continuous service development in a sustained effort to transform services as they do with products. It also created a stronger demand for service innovation researchers and theorists to develop new methods and strategies specifically designed to maintain the pace with fast evolving technological evolutions. In this chapter I argue that methods and models adopted in FTA can and should be permanently implemented in service innovation. While introducing some of the most established methods in the field of technology forecast, foresight, and assessment, I specifically focus on one, technology-oriented scenario analysis.

9.2 TECHNOLOGY-ORIENTED SCENARIO ANALYSIS AND STRATEGIC DECISION-MAKING

The history of humankind, and our own human nature, has always been characterized by an interest in the future. This interest has created, throughout history, a number of practices, and their practitioners, who have claimed to be able to see and forecast the future. These ancient traditions, and their often gaudy practices, took a drastic turn at the beginning of the 19th century when a new modern tradition, started by the likes of Copernicus, Kepler, and Galileo, matured into the development of specific practices that wanted to reach a scientific understanding of the future. This understanding was based, on the one hand, on the observations of the laws of nature and their predictability, and on the other on the study of social patterns and behaviors. These scientific practices have soon turned their attention to the study of the significant social, economic, cultural, and behavioral shifts led by the evolution of technology, and the impact that developing and future technologies might have.

At the turn of the century and after the first and second world wars when the consequences of the wrong use of new technologies became painfully known, it quickly became clear that this forward thinking was a necessary condition for strategic decision-making. The core understanding was that: "Those who do not want to deal with the possibilities of the future were at far greater risk of being sidelined or being pushed towards possible futures they neither desired nor chosen" (Kreibich, Oertel, and Wölk, 2011).

The effort to control or guide the future became a strategic decision, and the ability to lead and govern technological developments became the tools to exert such control. For the past century this awareness has motivated a constant technological race in which different actors have continually competed for the definition of the future, and the social, economic, and political advantages created by the ability to control such futures by controlling technological developments and the adoption of new technologies. This constant effort has created extremely diverse fields of practice and diverse groups that, with different agendas, engage with one another, and try to influence diverse dimensions of technological developments and future scenarios for social, political, and economic advantage.

A byproduct of such an effort has been the creation of a fragmented technological timeline (well exemplified by the concept of the digital and energy divide) in which different groups' access, use and understanding of new or developing technologies has given them the advantage over other groups quite literally creating, in the same continuous time, a fragmented relative technological timeline where different groups live in the past, present, or future of one another. This is true for nation states as it is for different groups, businesses, and institution within them. As Gibson (2003) stated very evocatively: "The future is already here, it's just not very evenly distributed".

At the forefront of this timeline there are the experts and the practitioners of the future: the innovators and researchers in their research facilities, scientists in their laboratories, the policymakers, artists, film makers, novelists, philosophers, economists, and business visionaries who are constantly "living in the future", or speculating about the possible futures that might be elicited by the advancement of specific technologies and the impact of their adoption. These groups are followed by the early technological adopters: the states, the public and private institutions, businesses, social groups, and individuals who, earlier than others, invest or speculate on the advantages that can be gained, or challenges that can be posed, by certain technological evolutions.

The economic, social and political advantage and the challenges created by these possible technological scenarios have created an increasing need to engage in forms of future scenarios analysis. These techno-centric analyses of the future have evolved into three different directions and practices: technology foresight, technology forecasting, and technology assessment. The difference among these interconnected approaches is somewhat slippery, but their different emphases are meaningful and can be exemplified through a basic review of their definition, and associated methods, to gain a sense of their history and trajectory.

Technology Forecasting relates to a set of analytical and interpretative activities that aim at capturing the expected trend and growth rate of existing or developing technologies. This is a practice consistently used by businesses and organizations to assess and plan short- to medium-term strategies and is at times associated with the term "technological intelligence"; an activity that enables companies "to identify the technological opportunities and threats that could affect the future growth and survival of their business" (Mortara et al., 2007). Methods used in technology forecasting include, according to a categorization made by Louie (Louie et al., 2010): Judgmental or Intuitive Methods such as the Delphi method (Dalkey, 1967; Dalkey et al., 1969); Extrapolation and Trend Analysis based methods such as Trend Extrapolation (Moore, 1965); Gompertz and Fisher-Pry Substitution Analysis (Fisher and Pry, 1970; Lenz, 1970); Analogies (Green and Armstrong, 2004, 2007); Morphological Analysis (XWY); Models-based methods, based on the Theory of Increasing Returns (Arthur, 1996); Chaos Theory and Artificial Neural Networks (Wang et al., 1999); Influence Diagrams (Howard and Matheson, 1981); or methods based on Scenarios and Simulations (Kahn, 1960, 1962).

Technology Foresight is described by Martin (1995) and Georghiou and Keenan (2006) as "the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits" (Martin, 1995) and assess the ones that might have the strongest "impact on industrial competitiveness, wealth creation and quality of life" Georghiou (1996). A significant number of approaches and methods have been developed or used for technology foresight. The well-known paper by the Technology Futures Analysis Methods Working Group (Porter et al., 2004) identified 51 methods divided into nine groups (13 groups according to Porter, 2010) that can and have been used for technology foresight. These are qualitative, quantitative, semi-quantitative (Popper in Georghiou et al., 2008) methods that have been divided by Porter in the following groups: Creativity Approaches, Monitoring & Intelligence, Descriptive, Matrices, Statistical Analyses, Trend Analyses, Expert Opinion, Modelling & Simulation, Logical/ Causal Analyses, Road-mapping, Scenarios, Valuing-Decision Aiding-Economic Analyses, Combinations (ibid.).[2]

Technology Assessment is a "scientific, interactive and communicative process which aims to contribute to the formation of public and political opinions on societal aspects of science and technology" (Decker and Ladikas, 2004). The focus here is on the assessment of the socio, economic, political, and ethical consequences that the adoption of certain technologies might have for society at large. Methods used in Technology Assessment include, according to Tran and Daim (2008): structural modeling and system dynamics, impact analysis, scenario analysis, risk assessment, decision analysis, environmental concerns and integrated TA, cost–benefit analysis, measures for technology, road-mapping, scenarios and delphi, surveying, information monitoring, new technology assessment, and mathematical and other synthesis methods.

Future-oriented technology analysis (FTA) has, since 2008, become one of the many banners representing these efforts, and the product of this scientific history. A scientific, speculative, theoretical, and methodological effort to study and assess technological development is one of the key drivers in the evolution of these possible future scenarios. One of the core understandings in FTA is that technology and technological evolutions are subjects of a complex dynamic system that entails the interaction of different forces and the participation of multiple stakeholders. In this interpretation, innovation and foresight activities are not strictly localized activities, closed in the laboratories, corporate, or individual companies, or institutions but part of a move towards an open innovation ecology in which more and more information is shared among different knowledge providers. FTA has come to represent the attempt to coordinate the efforts of this multitude of groups and interests that are now using different scientific methods and approaches to study, forecast, and evaluate possible future technology-based scenarios. In the context of innovation, and service innovation specifically, this field of research, its principles, and history are meaningful to focus the attention of innovation researchers and practitioners on a number of pivotal aspects: 1) technology and information technologies are inextricably linked with service and they represent both an opportunity and a challenge to service innovation; 2) technology has become an increasingly fundamental driver of change in service innovation, and reflections about the role of future technological developments cannot be excluded in any medium or long-term service innovation plan; 3) service innovation has to adapt and adopt new methods and strategies specifically designed for technology forecasting and foresight. Specifically, I argue, it needs to integrate future scenarios, and hypotheses generation methods, and analyses; and 4) Technology forecast and foresight methods and analyses should be understood as dynamic processes of organizational intelligence. They are designed to activate key and dependent actors to collaboratively participate in a systematic, methodologically structured, but open and creative analytical activity inspired by reflection on possible future scenarios.

To further illustrate the core thinking in the field and its motivations, the following elaboration by Schoemaker (1995) presents a particularly illustrative perspective for which it deserves to be quoted at length. He explains why future-oriented scenario analysis constitutes a key methodological approach among these analytical strategies:

> Early in this century, it was unclear how airplanes would affect naval warfare. When Brigadier General Billy Mitchell proposed that airplanes might sink battleships by dropping bombs on them, U.S. Secretary of War Newton Baker remarked, "That idea is so damned nonsensical and impossible that I'm willing to stand on the bridge of a battleship while that nitwit tries to hit it from the air." Josephus Daniels, Secretary of the Navy, was also incredulous: "Good God! This man should be writing dime novels." Even the prestigious Scientific American proclaimed in 1910 that "to affirm that the aeroplane is going to 'revolutionize' naval warfare of the future is to be guilty of the wildest exaggeration." In hindsight, it is difficult to appreciate why air power's potential was unclear to so many. But can we predict the future any better than these defence leaders did? We are affected by the same biases they were. It was probably as hard for them to evaluate the effect of airplanes in the 1920s as it is for us to assess the impact over the next decades of multimedia, the human genome project, biotechnology, artificial intelligence, organ transplants, superconductivity, space colonization, and myriad other developments. The myopic statements in the sidebar remind us how frequently smart people have made the wrong assumptions about the future with great certainty. Managers who can expand their imaginations to see a wider range of possible futures will be much better positioned to take advantage of the unexpected opportunities that will come along. And managers today have something those defence leaders did not have – scenario planning.
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> (Schoemaker, 1995, p. 25)

9.3 A COMBINED THEORETICAL AND METHODOLOGICAL MODEL FOR TECHNOLOGY-ORIENTED SCENARIO ANALYSIS

Technology-oriented scenario analysis can be described as a specialized, or focused, application of similarly scoped exercises in scenario analysis. Ultimately, all scenario analyses aim to create multi media "representations" of certain visions of the near- (5–10 years), medium- (10–20 years) or long-term future (20–50 or more years). Technology-oriented scenario analysis, as a sub-genre of scenario analysis, can be described as an approach that specifically speculates about possible technological scenarios and the social, economic, and political relations and structures these technological evolutions might support or favor. Depending on their timescale and scope these scenario analyses might rely on quantitative, qualitative, or mixed research tools. The complex nature of these scenario analyses and the variety of methods they might apply explains why a singular methodological approach is neither possible nor desirable. A brief research on the subject is going to lead to an enormous variety of approaches and methods. Despite this diversity, however, it is still possible to look at the process and the different stages involved in the design of a scenario exercise and some of the elements they have in common. In the specific case of a technology-oriented scenario analysis there are also a number of theoretical and empirical considerations that might help to structure what seems so complex and difficult to classify. I argue that two principles are specifically important and helpful. One I call the principle of dialogic consequentiality, the other multiple stakeholder technology foresight.

9.3.1 Technology-oriented Scenario Analyses as a Scientific Discourse Genre, Based on the Principle of Dialogic Consequentiality

Contemporary futures studies are based on the core understanding that future developments, although not entirely predictable, are based on a set of conditions established in the past and the present. These conditions constitute the background for future developments that, although uncertain, are not arbitrary but the product of a complex series of decisions and actors that can potentially give shape to a number of differently possible, probable, or desirable future scenarios. The relative openness of these future scenarios gives scope to the idea that the future can be influenced or designed. The realization that these future scenarios cannot be totally arbitrary gives scope to the study of the conditions that can contribute to their evolution.

Independently from the tools used in the process, scenario analyses, and technology-oriented scenario analyses, only produce *descriptions and narratives* that detail certain aspects of a possible future. They might be said to share some of the qualities and insights that belong to other future scenario genres – science fiction and art not excluded – but they differ from these other forms of speculation and narratives because of *the process that leads to their narrative constructions*. While other forms of future speculation might be free from the need to specifically explain the history or the rationale that brought about the construction of such scenarios, technology-oriented scenario analyses are limited by the scientific conditions of existence of any technology, and the requirement of a consequentiality between the different steps that describe their potential evolution. Technology-oriented scenario analysis should really be considered as a creative, albeit structured, exercise in the construction of possible future scenarios that, starting from known elements of the past and the present (the known) moves via a number of scientific approaches, and associated scientific discourse genres (Miller and Fahnestock, 2013) into the future (the unknown). This timeline, composed of a series of key steps and necessary conditions, although uncertain cannot be arbitrary, but needs to be anchored in a consequential discourse. Each key step of the timeline, and hypothesis, needs to account for and describe the conditions of what was before and what follows. This does not mean that all details of this possible evolution need to be described, but rather that what are believed to be key steps or conditions need to be highlighted and consequentially analysed. Because of the hypothetical, and multiple, nature of these scenarios any narrative timeline should always be considered as "dialogic" (Bakhtin, 1982), open to a continual dialogue and to further elaborations, to alternative hypotheses, or challenges by alternative scenarios, discourses, and interpretations.

These speculative efforts can go outward towards the future, moving from a set of chosen conditions, or inward moving from a hypothetical future condition back to the present. If looking at the steps that could lead to a future scenario, this is known as an "exploratory" or "outward bound" (JRC European Commission) approach. The reverse is also possible. When starting from a hypothetical future, the analyses move backwards trying to investigate the precise line of events that might have led to that hypothetical future. This is known as a "normative" or "inward bound" (ibid.) approach. Both approaches have their purpose. What they do have in common is that they both have to rely on: a scientific discourse genre and a methodologically accountable, theoretically informed, data aware and data rich analysis and speculation about the past, present, and future; a systematic description and analysis of the necessary conditions and steps that might lead or cause such futures; and a dialogic openness to alternative hypotheses and interpretations. Practices that together combine in what I call the principle of "dialogic consequentiality".

9.3.2 An Integrated Theoretical Model for Technology Analysis and Foresight

Future-oriented Technological Analyses developed from the effort of creating a dialogue between different practitioners and groups that share a common interest in technology, technology foresight, technology forecasting, and technology assessment. Cagnin and Keenan (Cagnin, Johnston, Keenan, and Barre, 2008) in their reconstruction of the various stages that characterized the field used Georghiou's (2001, 2007) five generations model to identify the key theoretical traditions and methodological approaches that characterized the history of the field. These five generations describe a process of increasing inclusion of actors and forces active in the process of technological development, and technology foresight. In the first generation the focus is on the experts, the developers of technology, and their forecasts. In the second generation a link is recognized between the financial markets and their speculations and technology. In the third generation the influence of user- and users'-based social trends are recognized as an influence. In the fourth generation technology, foresight has reached a more distributed role in the science and innovation system, with many organizations conducting their own foresight activities. In the fifth generation, these efforts become distributed among many sites that focus on either the structures, actors of technological development, or "on the scientific-technological dimensions of broader social and economic issues" (Cagnin et al., 2008, p. 3). Of course many, if not most, projects exhibit characteristics of different generations that are not mutually exclusive.

There are a number of models and analyses that link one or more of these groups and forces to technological evolutions, for example, in the work of Melissa Schilling, Robert Burgelman, and Clayton Christensen on strategic management and technology and innovation. Or on user-driven innovation, such as in the work of Eric von Hippel. Increasing attention has been lately paid to the relations existing between politics and technology. These approaches either focus on selected forces and groups or claim the existence of different historical stages in which attention has been turned to one aspect or group, or the other.

Consistently with contemporary analyses that focus on multiple stakeholder processes, I suggest (Lapenta, 2013) an integrated model that sees technological evolutions as the product of the constant interaction of a number of key representative groups and interests (Lapenta, 2011). These stakeholders groups (and decision-makers), that for the sake of this discussion can be broadly defined as the "developers," "policymakers," "financial actors," "users and users' groups"[3] (Lapenta, 2013), with their combined interactions, and driving forces, are responsible for the path of evolution and trajectory of any technology. The model also recognizes that "technology" itself, as well as being influenced by these groups and forces, once adopted will exert an influence of its own on the other groups and forces, social trends, their trajectories, and dynamics.

The recognition of these interlinked influences acknowledges that you cannot really understand the evolution of any technology without understanding and accounting for the interrelation of all these forces – forces and influences exercised, at different times and for different periods of time, by these different groups that, together, work in shaping a technology's trajectory and fate. It also understands that these groups are part of social trends and trajectories of their own, which are formed and extend in a time frame not necessarily consistent with the time frame of other groups' trends and trajectories, or to technology (and specific technologies life cycles). These specific stakeholders groups' trends and trajectories, such as fashions among users, national and global policies for policymakers, financial market phases and inner dynamics; private or public investments' fashions or priorities; and policy groups' priorities and focus, are all characterized by unique time frames that vary in subject and duration, and direct or indirect influence on specific technology's related evolutions. A specific time frame might appear to give relevance to one group's influence or another's, at a specific time, for a specific technology, but in this interpretation and model *these forces are always all interrelated* and part of *any* technology's evolution, and their interactions and intersections can always be observed by narrowing or extending the time frame under observation. This time frame, and the underlying social trends and trajectories under observation, can start in the past and move to the present, as well as be extended into the future. One meaningful way to understand the evolution of any technology, I argue (Lapenta, 2013), is to position that technology within this system of different groups and forces, and their specific trajectories, and study and describe how and when they intersect and with what consequences (for an example[4]).

A limit of this model is that the reduction of the key actors to those four groups, although meaningful, can be seen as reductive, but this is beyond its function. The function of the simplification of this model is that it compels researchers to always consciously apply a basic multiple stakeholders' approach that at least accounts for these fundamental forces (however defined in context). The model also helps to understand how to adopt a motivated and variable time frame for the analyses, that instead of focusing on the sole technology (as in a technology-based trend extrapolation and life cycle analysis) focuses and accounts for the long- and short-term social dynamics, and key actors' own social trends and trajectories, in which any technological evolution is embedded. These time frames are most likely going to be different from the ones of the very technology itself. This approach has an equal value when investigating the evolution and impact of existing technologies and also, although more complex, when evaluating the groups and conditions that might favor or hinder the development of a yet to be adopted technology, and the effects that that technology might have on the other groups and forces.

9.3.3 A Methodological Model to Conduct Technology-oriented Scenario Analysis

What is meaningful about the two theoretical dimensions and considerations outlined above is that they allow us to describe a set of theoretical and methodological guidelines that should help to initiate any form of technology-oriented scenario analysis. Scenario analyses can be divided in two main approaches: "exploratory" or "outward bound," or "normative" or "inward bound." Scenario analysis speculative efforts can go outward towards the future, moving from a set of chosen present conditions, or inward, moving from a hypothetical future condition back to the present. Both approaches have their purpose, but they are not different in their underlying logic. What they do have in common is that they both have to methodologically rely on the principle of dialogic consequentiality to investigate the line of events that might lead to or have caused that hypothetical future. Both approaches have also to thoughtfully apply a defined multiple stakeholders' approach that moves towards the identification of the key actors and driving forces involved in the scenario. They both have also to use a motivated and variable time frame for the analyses, that instead of focusing on the sole technology's life cycle focuses and accounts for the long- and short-term trajectories or social trends that might characterize these key actors' hypothetical actions.

There are many different approaches that can be used to initiate, structure, and organize long- or short-term scenario exercises and scenario foresight activities and analyses. Scenario exercises can be long or short-term activities, organized as single workshops, or more long-term activities, and involve a variable number of different stages, and varying numbers of participants and stakeholders. Given this diversity, we are more interested in the methodological phases and functions that need to be accomplished by these activities than in the specific organizational aspects of these activities. One well-known model that describes the basic research phases of a scenario exercise is described by Schoemaker (1995, p. 29). Another that is specifically framed within the area of FTA is suggested by Kreibich, Oertel, and Wölk (2011, p. 19). Combined together they give a good sense of how a scenario exercise can be structured, its key phases, and their methodological function. Kreibich, Oertel, and Wölk describe six phases in a scenario exercise: *framing, scanning, forecasting, foresight, visioning, planning and action*. I will shortly describe them, combining them with Schoemaker's scenario while using an example, and possible application, in financial services innovation to contextualize them.

Framing

In this phase the scope of the scenario exercise is defined. Key elements are defined such as the key area of investigation, the time frame of the exercise, the main stakeholders involved, and an initial problem formulation that defines what areas of a certain technological development or possible evolution the researchers are interested in. (For example, what will be the future of online banking and financial services in relation to the development of mobile technologies and applications in ten years from now?)

Scanning

In this phase all kinds of relevant data and information are collected based on the themes identified in the framing phase. Those available such as published research and reports, historic analyses, and current research data and analyses, can be integrated by qualitative and quantitative research, interviews, surveys, expert opinions etc. (in the case of the online financial services and banking, for example, a meaningful amount of research and data is published by institutional organizations, such as in the Board of Governors of the Federal Reserve System report on consumers and financial services, or research institutes and think thanks).

Forecasting

In this phase the collected data are analysed to identify and discuss key trends, uncertainties, and drivers of change (for example, in the case of the financial services regarding mobile services development, security and privacy concerns associated with mobile applications, trends and challenges in privacy legislation, and technological developments in secure networks).

Foresight

In this phase, on the basis of the analysis and results of the forecasting phase, a number of hypotheses and possible future scenarios are explored, challenged, compared to alternative cases, and tested for relative consistency and plausibility (for example, what if cash payments were declared illegal? Or what if national currencies were all replaced by one single digital currency? What would be the consequences of such evolutions for financial infrastructures and services? While the former are somewhat utopian scenarios, they open the discussion for a possible multiple scenario analysis in which various scenarios, that account for intermediate possibilities, can be explored. Such as, for example, the case in which the use of cash was limited only to specific transactions or anyway somehow regulated, and digital currencies evolved in parallel to older monetary systems).

Visioning

In this phase the lead scenario or scenarios that have emerged from the framing, scanning, forecasting, and foresight phases are tested more in depth. A more strategic, detailed and articulated discussion of the necessary conditions, and the actors' necessary steps involved in a specific scenario, and their relative likelihood, are analysed and carefully evaluated. (Qualitative and/or quantitative models can be tested, for example, to evaluate the likelihood of cash transactions disappearing in 5, 10, 20 or 50 years' time, and/or new electronic currencies to take over in similar time frames.)

Planning and action

Following the insights of the analytical stage of the vision building phase, a number of strategies, options, agenda setting considerations, or actual development plans might be developed to act on the insights produced by all the previous phases (in our case, for example, it can be decided that a certain amount of resources will be assigned to the long-term development of financial services based on these new scenarios).

9.4 WHEN FORECASTS AND FORESIGHTS ARE WRONG, WHEN THEY ARE RIGHT, AND WHEN IT DOES NOT MATTER IF THEY ARE.

Foresights and forecasts are predictably complex activities. A wealth of empirical evidence proves that very often attempts to predict future behaviors is incredibly complex, and often wrong. Political forecasts and economic analyses, and micro and macro economic modeling, are known to be often very imprecise, many times intentionally or unintentionally biased, regularly entirely wrong. While this is often the case even with theoretically more predictable dimensions (such as the ones governed by the laws of nature – weather forecasts, for example), it is even more common when dealing with human behavior, and human decision-making activities where their limitations become even more apparent and predictable (Schoemaker, 1998). These limitations might question the advantages that can be gained by such foresight activities, and the costs associated in running them, especially considering how many times these forecasts are wrong. A general answer to this question is that in many contexts it is not really important if the predictions were right or wrong, and the accuracy of these scenarios might really not be the main reason why these scenarios exercises are done:

> Many times the aim of these forecasting and foresight practices is not to be correct about their predictions of the future. Often their aim is to force decision-makers into a critical process of constant engagement with possible future scenarios. Rather than a tool for prediction, they are a tool to favor a process through which new insights emerge, new organizational skills are developed, medium- to long-term visions are conceived and tested, and strategic decisions are taken. So that future scenarios can be influenced and built, or as it might be the case, intentionally avoided. Having explored several scenarios and their possible consequences is also a resource in its own right. These scenario-building practices can be a very powerful tool to train decision-makers to quickly evaluate emerging scenarios, and react more effectively to otherwise unforeseen actual events.

9.5 BIG DATA AND ALGORITHMIC PREDICTIVE COMPUTING: EVOLVING PRACTICES OF FUTURE SCENARIO ANALYSES

The field of FTA and the scientific investigation of the future are in their relative infancy. Until very recently they were based as much on expert knowledge and science as they were on individual creative and analytical skills. Things are, however, changing very rapidly. Speculative foresight is more and more replaced or assisted by developing forms of "algorithmic predictive computing" (Lapenta, 2013) and more mathematically and statistically formalized forecast and foresight activities. As one of the fastest developing areas of research, these developments are influenced by parallel developments in big data collection, better and more sophisticated mathematical modeling, and the constant push towards an artificial intelligence-based analysis of an increasingly growing and diversified amount of data. Because of this consistent growth of foresight and forecasting activities, and projects and institutional investments, an increasing amount of data and tools are made available by many different authors and organizations, some small such as think thanks and research institutes, and others representing the articulated effort of national or international institutions. These research, data, tools, and applications, scenario analyses and reports are often provided with the hope of eliciting debate, discussion, speculation and further elaboration by the widest range of individuals, groups, and stakeholders. They constitute an invaluable resource. Despite these changing tools, and the certain evolution of new methods and tools, foresight and scenario analyses ultimately remain an intellectual exercise in understanding the forces that contribute to the future and its possible alternative evolutions. Foresight should be understood as a process for understanding the developing relations among key actors and their individual and collective contributions to the development of the future – a process to critically problematize the consequences of different actions, and the possible future scenarios that these actions and decisions might lead to or inspire. Technology foresight should really represent a checks and balances system in which the role of the intellectual and the researcher is to foresee the evolving and invisible structures of power established by technology, and question the values of their irresistible evolution; the role of the creative thinker and maker is to imagine these technological evolutions and make them possible; and their combined effort should contribute to making sure that the sole purpose of technology and innovation will be to serve the evolution of humanity in its ethical quest for purpose and direction.

LEARNING POINTS

- Information Technologies and Technology have become structural drivers of change. Any medium- or long-term innovation plan cannot exclude reflections about probable and possible future technological developments.
- Innovation in Technology and Information Technologies are inextricably linked with service innovation. Their evolution represents both an opportunity and a challenge to service innovation.
- Technology forecast and foresight methods should be understood as new, necessary, and dynamic processes of organizational intelligence. They are designed to activate key and dependent actors to participate into a constant innovation process inspired by, and aware of, possible future technological scenarios.

DISCUSSION TOPICS

- What theoretical model can be used to understand the different forces that contribute to technological development and innovation?
- What methods and analytical tools can be adopted to forecast, evaluate, and influence possible future technological scenarios?
- How can technology-oriented scenario analysis be implemented and used for innovation, and service innovation, research and development?

NOTES

1. The origin of the term"future-oriented technology analysis"can be traced to the planning for the Institute for Prospective Technological Studies Seminar 'New Horizons and Challenges for Future-oriented Technology Analysis: New Technology Foresight, Forecasting and Assessment Methods' held in Seville, Spain in May 2004.
2. For an accessible overview I suggest reading Popper, R. (2008) "Foresight methodology." In L. Georghiou, J. Cassingena, M. Keenan, I. Miles, and R. Popper (eds.), *The Handbook of Technology Foresight*. Cheltenham, UK and Northampton, MA, USA: Edward Elgar Publishing, pp. 44–88. For a complete list of methods and references to each method I suggest looking at the original paper by the Technology Futures Analysis Methods Working Group (2004).
3. For an example of the application of this model you can watch my presentation at Re:publica 2013 in Berlin (https://www.youtube.com/watch?v=wJYtHBD0XbI) in which I adopted this model to speculate about emerging geolocational augmented visualization technologies against historical, technological, social and economic trends, and elaborate on the basis of these interpretations on the specific normative, and cognitive effects, that these technologies might acquire.
4. Kahn (1960) *On Thermonuclear War* and (1962) *Thinking About the Unthinkable* are notable examples. They are also the first two scenario exercises that defined the method.

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