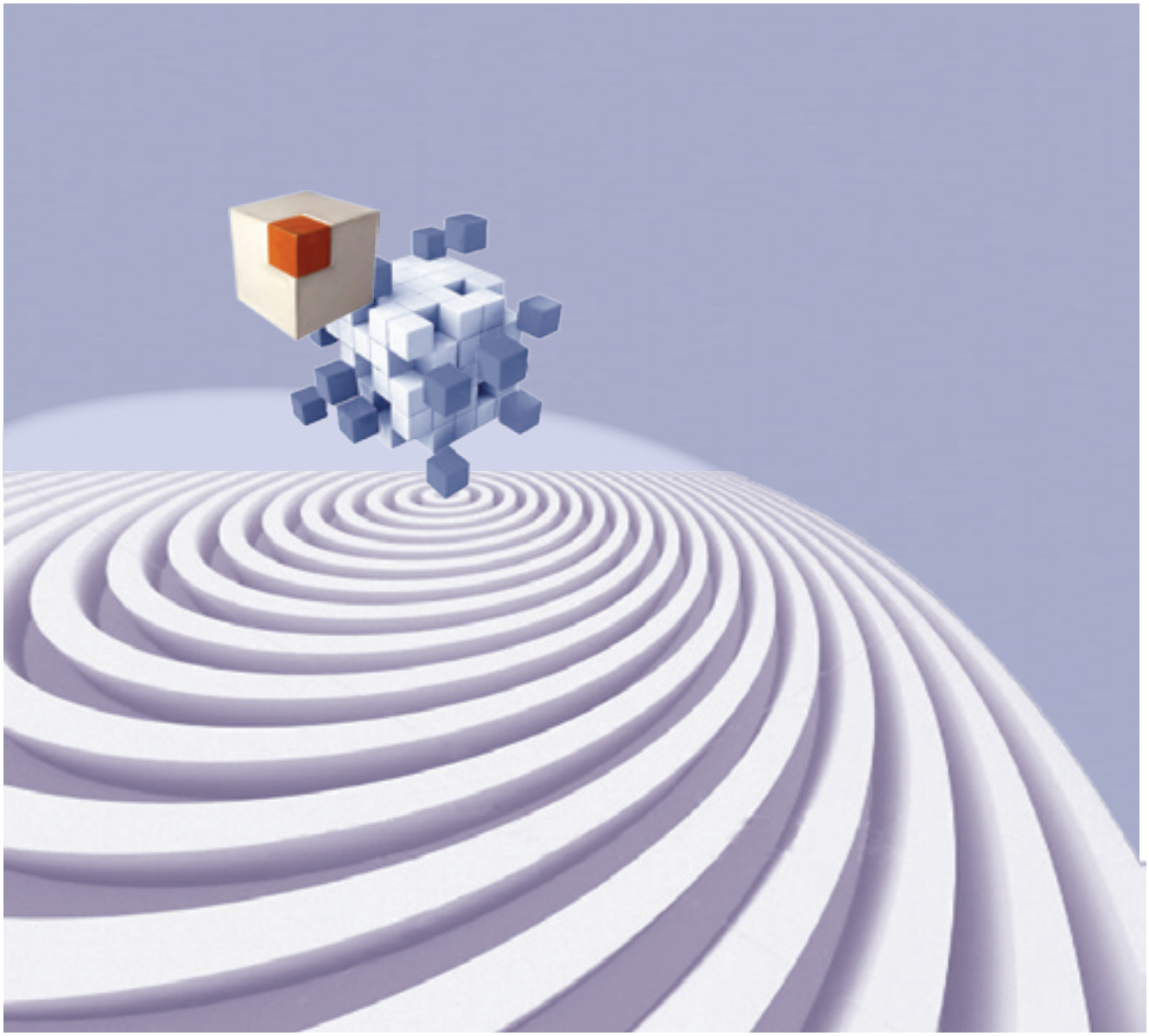
Master Class

STI Foresight in Brazil

Cristiano Cagnin



Globally, advanced countries and institutions emphasise Foresight studies that create spaces for structured dialogue with a focus on systemic or transformative innovation. Aligned with the coordination of societal actors, foresight processes of that kind aim to better enable innovation systems to address common challenges. In doing so, foresight activities become more relevant and have greater impacts in decision-making processes.

The analysis of the evolution of Foresight in Brazil presented in this paper shows a greater role of such studies in formulating science, technology and innovation policy. Foresight projects carried out by the Brazilian Center for Strategic Studies and Management in Science, Technology and Innovation (CGEE) raise new strategic questions that should be investigated and addressed to reorient the Brazilian National Innovation System.

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Keywords

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In essence, the objective of foresight is to shape spaces for structured dialogue that fosters engagement, creativity and reflection, both individual and collective. Hence, the aim to use the future as a trigger to spark imagination and expand our understanding of the present through structured conversation to collectively imagine the future and make choices in the present [*Miller,* 2007; *Miller,* 2011a; *Miller,* 2011b].

Various methods, tools, instruments and techniques are used to structure dialogue and shape possible future developments. However, understanding the relationship between context, content and approach is critical in the design and implementation of a foresight process [*Cagnin et al.,* 2008]. Moreover, expected results and associated impacts, both tangible and intangible, should be defined from the outset [*Da Costa et al.,* 2008].

Foresight approaches have evolved over **successive generations or phases**, which are not mutually exclusive [*Johnston,* 2002, 2007; *Cuhls,* 2003; *Georghiou,* 2001, 2007]. Briefly, these phases are: i) technology forecasting or internal dynamics of technology with expert participation; ii) the interaction between technology and markets, with participation from across the academic-industry nexus; iii) the interaction between markets and social actors, with an user-oriented perspective and broader societal participation; iv) a disseminated role in the science and innovation system, with multiple organisations carrying out exercises fit for individual purposes but coordinated with other activities; and v) a mix of distributed exercises focused on either structures or actors within the Science, Technology and Innovation (STI) system, or on the scientific/technological dimensions of broader social and economic issues and challenges.

Foresight practice occurs mainly in **two 'modes'**, although a combination of both is possible and becoming commonplace. In 'mode 1' the aim is to improve or optimise the existing system [*Weber*, 2006; *Eriksson, Weber,* 2006; *Havas et al.,* 2007]. 'Mode 2', on the other hand, focuses on debating and promoting fundamental changes of established paradigms [*Da Costa et al.,* 2008]. At the same time, a number of **principles** guide foresight work (adapted from [*Keenan et al.,* 2006]): i) a medium to long term perspective; ii) active participation of stakeholders; iii) the use of evidence and informed opinions, thus combining interpretative and creative approaches; iv) coordination; v) multi-disciplinarity; and vi) action-orientation.

Globally, advanced countries and institutions practice a combination of phases four and five as well as 'modes' 1 and 2. This takes place routinely and with close attention to the six principles mentioned above. The aim is to make foresight activities more relevant and have greater impact in the decision making process, such as in the design and implementation of public policy. The Center for Strategic Studies and Management in Science Technology and Innovation (CGEE) is, therefore, aiming to advance in this direction rather than concentrating efforts only in the first and third generations and in 'mode 1'.

Foresight Evolution

The post-industrial revolution caused many social and technological transformations and saw a sense of preoccupation towards the future become more widespread. During that time, attention was on improving decision processes and public debate, and on anticipating the trends and long-term implications of short-term decisions.

In the 19th and 20th centuries classical economists centred their analyses on the future of capitalist economies. The early 1900s saw the establishment of the principles of trend extrapolation and social indicators. The term foresight appeared in a speech delivered by H. G. Wells for the Royal Institution of Great Britain in 1902 entitled 'The discovery of the future', which argued that the future could be known or understood scientifically [*Wells*, 1913]. The first systematic methods of experts' analysis and the first simulation studies were developed in the second half of the 20th century (e.g. Delphi and cross impact analysis).

In the 1930s and 1940s, when the effects of the Great Depression were very pronounced, a new world order looked at science and technology (S&T) as a means to recovery. H.G. Wells published 'An Experiment in Prophecy' in which

he anticipated the world in 2000: he predicted modern transport dispersing people from cities to suburbs, moral restrictions that were diminished due to sexual freedom, and the formation of the EU (e.g. [*Wells,* 1901a; *Wells,* 1901b]). In 1932, Wells also defended the institutionalisation of what he called the 'departments and professors of foresight.' In 1945, a committee had the task to look ahead 20 years to envision the evolution of the aviation sector and identify the steps needed for the US Air Force to get there. Future studies initiated towards the second half of the 1940s when institutions like the think tank RAND Corporation (Research ANd Development Corporation) and SRI International (SRI) were created to develop long-term planning by analysing systematic trends for military purposes soon after the WWII.

Following the end of WWII and the start of the Cold War, during the 1950s and 1960s, the focus of future studies turned to anticipate future technologies, mainly for defence objectives. RAND and SRI used system analysis and developed games theory, and scenario and Delphi methods. The focus was on S&T and engineering, developed by and for military application and big corporations. A limited number of experts and futurists were involved in these activities, and the main methods used were Delphi, scenarios, brainstorming and expert panels. Foresight's conceptual and methodological basis developed in this period. Hence, this is considered to be the birth of modern foresight practice based on operational research efficiency and aiming at deliberate interventions to direct desired change. Foresight practitioners were mainly concerned about probabilistic analysis of what may happen in the future based on an extrapolation of past events (i.e. forecasting). Key works in this period include 'The art of conjecture' [*de Jouvenel,* 1963] and 'Inventing the future' [*Gabor,* 1964]. In 1966, the first future-oriented university course was developed in the US by Alvin Toffler at The New School (New York).

During the 1970s, the world began to understand the limits of forecasting due to the oil crises and the failure of predictions such as 'Limits to Growth' [*Meadows et al.,* 1972] and 'Catastrophe or New Society?' [Bariloche Foundation, 1976]. Unpredictable events led to a wider understanding of the uncertainty and complexity of global systems.

Forecasting in the 1970s came to be less deterministic, to 'accept' that the future is not a mere extension of the past, and to realise that discontinuities do occur. Japan uses forecasting methods about the future of S&T to inform its policies, including in its analysis of social and economic needs as well as advances in S&T. A number of activities started worldwide such as the Futuribles Project in France, the Committee for the Next 30 Years in the UK, and the Hudson Institute in the US (a spin-off of RAND). The EU developed the FAST Programme (forecasting and assessment in S&T) stemming from the study 'Europe +30.' One of the first attempts to institutionalise an activity looking at the future through the assessment of the likely impacts of technology was the creation of the Office of Technology Assessment (OTA) in the US (operational from 1972 to 1995). Projects mainly have social and political objectives and use methods that provide guidance and fundamentals to analyse alternative situations and choices, such as scenarios. General Electric and Shell started using scenarios to support their strategic decisions. In 1976, Shell looked ahead to 2000 by identifying discontinuities in the industry. After the oil crises (1974) almost half of the firms in the Fortune 1000 list of the largest American companies used foresight techniques in their planning processes. The same trends occurred in Europe [UNIDO, 2005].

In Brazil, the 1970s is considered the 'embryonic phase' of foresight [*Porto,* 2012; *Massari,* 2013]. Theoretical and methodological studies began to be published in Brazil towards the end of the 1970s. Henrique Rattner released the book 'Future Studies — Introduction to technological and social anticipation [*Rattner,* 1979]. The first formal group to think long-term (prospectively) on S&T policy was formed in 1979 at Unicamp by Amilcar Herrera. The first official and explicit document on S&T policy was published as part of the Development National Plan (I PND, 1972–1974): the Basic Plan of S&T Development (I PBDCT). The second PBDCT, integrated into the II PND (1974–1979) presumed the

creation of the National System of S&T Development (SNDCT) and the National Programme of Post-Graduation (PNPG). The latter demonstrated for the first time a harmony between a national plan and that of S&T [*Salles-Filho*, 2003].

In 1974, the CNPq (National Council for Scientific and Technological Development) launched the seeds of future studies in S&T policy with its programme of S&T Studies and Policies. This was reoriented in 1982 to support national and sector S&T policies looking at: i) the assessment of economic, social, political and environmental impacts; ii) trends and perspectives of the production system and S&T associated needs; and iii) future studies methodologies in S&T policy, with particular attention to scenarios.

In the 1980s worldwide exercises began to consider multiple futures embracing global and social uncertainties. In 1983 the term foresight came to be connected to S&T at SPRU in University of Sussex in the UK; in 1985, Michael Godet developed the school 'La Prospective.' Institutional foresight caught the attention of national governments as an activity associated with identifying long-term priorities and developing S&T policies. Activities developed in France (National Colloquium on Research & Technology) and the Netherlands (Ministry of Education and Science) are good examples [*Papon,* 1988; *van Dijk,* 1991]. The EU launched FAST Programmes 2 and 3. In Latin America an attempt called 'Prospectiva Tecnológica para América Latina' (1982) tried to identify the main trends of technological change that could become widespread in the next decades and the social, environmental and cultural impacts of technological change in Latin America.

In Brazil, the 1980s was considered to be the 'emergency phase' of foresight [*Porto*, 2012; *Massari*, 2013]. In 1985, the first formal course in future studies was delivered to government agencies and bodies, and in 1988 CNPq organised the country's first International Seminar in future studies, evaluation and social participation. Scenarios started being used in the second half of the decade by governmental companies that operate in long-term sectors such as energy [*Buarque,* 1998]. Examples of this are the BNDES (a development bank) which embedded scenarios in its strategic planning process in 1984; Eletrobrás/Eletronorte (an energy firm) in 1987; and Petrobrás (an oil company) in 1989 to analyse the market and demand for energy and fuel. In fact, Petrobrás initiated the use of scenarios together with BNDES in 1986. In 1987 CENPES (the research branch of Petrobrás) developed its first technological scenarios, and in 1989 scenarios became an intrinsic part of its strategic planning.

Scenarios also had an influence on business and academic environments. The results of the 'scenarios for the Brazilian economy — competitive integration' [BNDES, 1984] proposed an update of the country's industrial structure, suggested measures to achieve an open and competitive economy, highlighted ways to renegotiate Brazil's external debt in the long term. These suggestions were later enacted by the government of President Fernando Collor in the 1990s.

In addition, the creation of the National Council of S&T (CCT) in 1985 influenced the rebirth of futures thinking in Brazil, although its fragile institutional setting (initially subordinated to SEPLAN/PR) and excessive preoccupation with a short-term agenda led to the termination of long-term planning. The ministerial management of S&T in the period known as the New Republic (1985–1990) improved financial and operational aspects but did not fix problems of insufficient coordination.

Foresight exercises in the 1990s were widely undertaken by governments, the national academy of sciences and other governmental departments worldwide, industrial associations, firms, as well as by advisory groups and research advisors. Large-scale programmes took place in Germany, France and the UK, which inspired other EU and OECD countries, as well as Latin American and Asian countries (notably Japan, Korea, China and India) to initiate their own national programmes. Science and Technology were the central foci of these activities that aimed to identify strategic areas of research and emerging technologies that could reap economic (competitiveness) and social (visions, networks, education and culture) benefits. International groups and institutions were created such as the Global Scenarios Group, the Millennium Project and the Joint Research Centre Institute for Prospective and Technological Studies (JRC-IPTS).

In Brazil, the 1990s were considered to be the 'dissemination phase' of foresight [*Porto,* 2012; *Massari,* 2013]. EMBRAPA (a governmental food research firm) adopted a long-term approach in its strategic planning. The agribusiness and value chains became important concepts for a more systemic understanding embedded in future analysis. The creation of a new CCT (National Council of S&T) established two boards: i) prospective, information and international cooperation; and ii) regional development. The first board enabled an in-depth debate around the future of the National Science and Technology (NST) system leading to yet another rebirth of futures thinking and its embeddedness in the public sector. Themes like future technologies and the role of information as a transformative instrument gained attention. In 1997, a study was proposed emulating the French Key Technologies project and aimed at identifying technological priority topics of S&T in sectors. The objective was to shape the decisions of CCT as well as to involve the Ministry of S&T and the public sector in thinking about the future in order to define future priorities and strategies. In 1998, the project Brasil 2020, which was initiated at SAE was the first governmental experience in undertaking integrated planning for the country in recent years. It aimed to foster a reflection about the kind of country Brazil would like to be and what was needed to transform such a vision into a reality [*Sardenberg,* 2001]. Workshops and interviews generated input for scenarios, and a broad consultation of social actors tried to grasp societal aspirations. Equity, justice and quality of life were central aspects of society's hopes and ambitions: all are still valid today.

As the complexity of societies increased globally, from the year 2000 the scope and focus of foresight activities enlarged to cover a number of themes. Foresight exercises changed from emphasising scope and coverage to the process, adapted to a world with greater complexity, interconnectivity and interdependencies. Foresight tried to answer the grand challenges and needs for sustainable public policy in an adaptable way. The understanding of complex systems and possible future behaviours of social actors became the departing point and the focus became challenges instead of decision-making bodies. Coordination of societal actors to solve common problems was sought out, and foresight became institutionalised in Australasia (Australia, Korea, China, Taiwan, Singapore, etc.) beyond the EU and Japan, amongst other countries. UNIDO, in 2000, launched an ambitious programme of Technology Foresight for Latin America and the Caribbean, and UNESCO developed possible scenarios and social policies for Latin America and the Caribbean in the project 'Rethinking Latin America' (2011).

In Brazil, the 'continuous dissemination and generalisation phase' of Foresight began in the year 2000 [*Porto,* 2012; *Massari,* 2013]. The sectoral funds and a movement initiated by the Ministry of Science, Technology and Innovation (STI) led to a revolution in STI at the beginning of the 2000s. However, these have been partially discontinued in recent years. Nevertheless, the seeds that germinated from the CCT resulted in the creation of the ProspeCTar programme (Ministry of STI) and, to a certain degree, the Brazilian Programme of Prospective Industrial Technology (PBPTI) within the Ministry of Development, Industry and Commerce (DIC) in partnership with UNIDO. Delphi methods were the main technique used. The project 'Tendencies' of the Ministries of STI and DIC supported by the Sectoral Fund of Oil and Gas aimed to achieve a wide understanding of trends for the sector over the next 10 years. The methodology embraced scenarios, diagnosis, desk research, text mining, expert panels, web Delphi, and other methods. The project's 'strategic directives' (DECTI) resulted, in 2001, in the Second National STI Conference and in the creation of the Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE) to institutionalise foresight and policy evaluation studies nationally. According to Santos and Fellows-Filho, other results from the Second National STI Conference were the publication of the Green Book (showing the STI trajectory over the last 50 years together with transformative initiatives and future opportunities) and the White Book (showing the STI issues that national STI policy should tackle over the next 10 years to 2012 to consolidate a national STI system) [*Santos, Fellows-Filho*, 2009]. The project 'Brazil 3 Times' (NAE/

PR) aimed to define the strategic long-term objectives for the country and to build a pact between the state and society to achieve these objectives, beyond trying to institutionalise a long-term vision in public strategic management. The project mainly used scenarios. Embraer (an aviation firm) uses scenarios and Delphi routinely and, more recently, simulation systems to detect emerging signals. Technology foresight in Brazil is used as an instrument to formulate STI public policies with a focus on sectors and value chains. However, despite all the above-mentioned activities, the results have not had the expected impacts as they have in other countries. Aulicino observes that possible failures reside in the ways in which these exercises were formulated, designed and executed [*Aulicino,* 2006]. According to him, all lacked public participation. In addition, Aulicino argues that there was a lack of understanding of the concepts, objectives and expected impacts of these exercises, which led to little engagement and sharing of ideas between social actors, as well as the absence of new networks that were expected as a result.

Table 1 summarizes the stages of Foresight evolution worldwide, and Table 2 — these for Brazil.

Foresight in Brazil is still marked by a dichotomy between discontinuity and the institutionalisation of activities that can become embedded explicitly in decision-making and planning processes. At the same time, the focus needs to shift from technology alone to innovation more broadly to identify and articulate anticipatory intelligence that serves to reorient the NIS systemically, thus embracing social, environmental, economic, political, technological and behavioural (values) aspects. Coordination between decision-making bodies (i.e. Ministries) and social actors (fostering broad societal participation) still needs to be more widely promoted with a focus on challenges or common problems. Moreover, fostering dialogue and participation instead of stakeholders' consultations alone is important for attaining a more systemic understanding of the challenges at hand as well as to build the commitment of individual actors to collective decisions. Finally, promoting these changes means that there is a need to shift the focus of foresight activities from optimisation alone to one that builds a bridge between optimisation and contingency at the same time as embracing uncertainty, complexity and creativity.

Orienting the National Innovation System through Foresight[1]

In recent years, the ways in which NIS can be reoriented to address grand challenges have been widely debated. According to [*Cagnin et al.,* 2012], these are challenges which are complex and difficult, even impossible, to solve by single agencies or through rational planning approaches alone. Academics and activists have understood this for some time and the articulation of these challenges is not new. The novelty here relies on the increasing attention given to such issues when formulating national STI policies. The reasons for this are complex. In part, it reflects the increasing perception of urgency in responding to a series of challenges that could, if neglected, have devastating consequences of a local or global scale in the next decades. However, it also reflects an attempt to redirect STI efforts, at

Table 1. **Evolution of Foresight worldwide**

Years	Foresight generation	Foresight mode
1950–1960s	1	I
1970s	2	I
1980s	3	I
1990s	4	I
2000s	4, 5	I, II

Source: author.

Table 2. **Stages of Foresight evolution in Brazil**

Years	Foresight generation	Foresight mode
1970s (embryonic phase)	—	—
1980s (emergency phase)	1, 2	I
1990s (dissemination)	2, 3	I
2000s (continuous dissemination and generalization)	1–3	I

Source: author.

[1] Cf. [*Cagnin et al.,* 2012].

least those financed by the public sector, to explicitly respond to political agendas. The central question is how to support such a mission focused on challenges to develop innovation practice [*Freeman,* 1970; *Rogers,* 1995; *Freeman, Soete,* 1997; OECD, Eurostat, 2005; *Fagerberg et al.,* 2004; *Hall, Rosenberg,* 2010] which is more directed and transformative through the use of foresight methods and approaches [*Cagnin et al.,* 2012].

Foresight processes and approaches offer decision makers the potential of seeing through disruptive transformations, which are necessary as a solution to or caused by grand challenges. From the perspective of transcending epistemological and ontological barriers to better respond to grand challenges, foresight brings long-term perspectives and different knowledge bases into the decision-making process. In doing so, it emphasises the multiple and holistic approaches under which it is possible to identify diverse triggers and instruments to shape the direction of innovation systems. These processes also help in the use and management of the uncertainties associated with the activities and functions of innovation systems [*Bach, Matt,* 2005; *Bergek et al.,* 2008; *Edquist,* 2008; *Hekkert et al.,* 2007; *Jacobsson, Bergek,* 2006; *van Lente,* 1993; *von Hippel,* 2005; *Woolthius et al.,* 2005], as well as with the future more widely. It does so through the creation of spaces for social, economic and political actors to meet and appreciate their positions vis-a-vis possible future directions of innovation [*Cagnin et al.,* 2012].

From the political perspective, the potential of coordination improves the communication and the understanding between different decision-making bodies that are giving support, therefore, for the emergence of an effective combination of policies that fosters innovation. Finally, the simple fact of participating in such processes can in itself be transformative by encouraging the adoption of new perspectives and the development of new abilities to detect and process weak signals of change. In this way, different approaches and processes can enable actors to become more adaptive and capable of realising systemic changes. To do so, foresight can assume different roles to orient innovation systems so that the latter are better able to respond to grand challenges [*Cagnin et al.,* 2012]. These roles can be grouped as follows: informing the decision making process, structuring and mobilising networks of actors, and enabling innovation system actors [*Barré, Keenan,* 2008; *Da Costa et al.,* 2008; *Cagnin et al.,* 2011; *Cagnin et al.,* 2012].

Foresight at CGEE

The mission of the Centre for Strategic Studies and Management in Science, Technology and Innovation (CGEE) is to promote Science, Technology and Innovation (STI) to advance economic growth, competitiveness and well being in Brazil. It does so by carrying out foresight and strategic evaluation studies in combination with information and knowledge management approaches and systems. At the core of its activities is its position and ability to articulate and coordinate diverse actors within the Brazilian National Innovation System (NIS). One of CGEE's institutional objectives linked to its mission is to lead foresight studies that generate anticipatory intelligence for the Brazilian NIS.

The institution is changing its approach to developing and addressing new strategic questions, and in recognising new issues, which merit further investigation via systemic and systematic observations and dialogue. It is doing so to evolve its foresight practice to combine generations one to five as well as 'modes' 1 and 2 (see introduction), and to enable its results to be better positioned to support a reorientation of the Brazilian NIS.

In this context, CGEE is undertaking a transformative process by changing its approach to designing, organising, implementing, managing and evaluating its foresight studies. The aim is to move from a normative and prescriptive approach to one that embraces complexity, emergence and novelty. The institution is moving in this direction to improve the quality and robustness of its anticipatory intelligence and to increase the preparedness of the NIS for disruptive events [*Cagnin et al.*, 2012]. CGEE is attaining this objective via the creation of spaces for dialogue between key players from different domains, with diverging views and experiences. These spaces are designed to develop vision- and consensus-building

processes for considering and inducing 'guided' processes of transformation, as well as to shape and define dialogues on likely transformations and policy discussions on tackling major changes, and on research and innovation agendas. A number of tools and approaches are being explored to enable the institution to advance in such a direction and to use the future to ignite and expand the collective imagination and understanding of the present.

It is important to note that the approach developed by CGEE considers three integrating themes that determine the quality of foresight processes [*Cameron et al.,* 1996]:

- **Expertise** (i.e. ability to understand the nature of the problem/challenge at hand, to recognise the emergence and substantive patterns of change from weak signals in a noisy environment and from collective distributed intelligence);
- **Creativity** (i.e. capable in the art of embracing 'know knowns', 'known unknowns', 'unknown knowns' and 'unknown unknowns', thus considering knowledge, opinions, speculations and conjectures. In addition, this includes the ability to imagine, to experiment and to interpret novel and transformative possibilities of the future in the present, the ability to embrace the emerging future, and the ability to tell stories through narratives and visualisation);
- **Interaction** between government, science and industry, policy makers and politicians.

Therefore, the aim of foresight at CGEE is to balance contextualised design with systemic and systematic qualitative and quantitative approaches, and to welcome unknowability and uncertainty as a source of novelty, thus also providing an invitation for creativity and improvisation. Working with possible, probable, desirable, plausible and reframed futures provides a way to work with unknowable futures and novel frames for imagining the future [*Miller,* 2011a; *Miller,* 2011b]. Foresight does so by exposing anticipatory assumptions and revealing the social processes and systems used to invent and describe imaginary futures [*Miller,* 2007; *Miller,* 2011a; *Miller,* 2011b]. The author affirms that such processes increase our capacity to imagine discontinuity and to put more effort into inventing what is unknowable, thus developing greater capacity to use the future; what he calls 'futures literacy'.

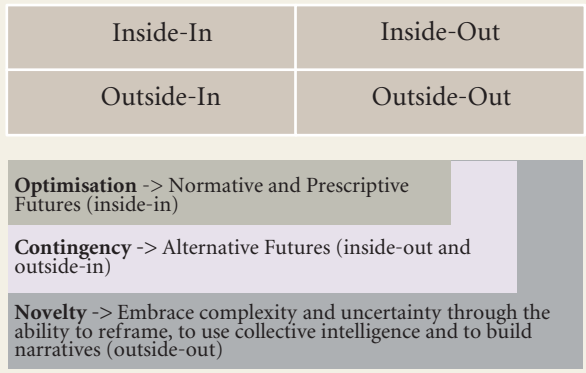
Developing the above mentioned balance implies building an ability to 'walk on two legs'[2]: to improve or optimise the current system simultaneously as it moves towards new and/or disruptive system configurations. Being able to operate in both known systems (inside-in, inside-out, and outside-in) with more efficiency and efficacy and operate in unknown systems (outside-out), according to Figure 1, will help the institution craft strategic questions for itself and its clients. In other words, looking outside the system with which we are familiar will help us develop and address new strategic questions, but also assist us in recognising new issues (e.g. challenges, technologies, social transformations, etc.) through systematic observations and dialogue, and in selecting those which are worth further investigating to identify new opportunities.

In short, optimisation focuses on the improvement of existing systems and looks at the future detached from the present. It usually allows for incremental innovation based upon a normative future with prescriptive actions associated. It prepares one to operate in known systems or 'inside-in' which, in other words, means that the boundaries of the system are well understood and only what resides within such boundaries are analysed.

Contingency, on the other hand, focuses on avoiding the undesirable events or on preparing the current system to continue to exist in the future. It also looks at the future detached from the present, and importantly looks at alternative futures instead of looking at one single vision alone. The aim is to enable one to prepare for different possibilities of the future regardless of whether these become a reality or not, as well as to shape a desirable pathway with checkpoints that —

[2] Presentation delivered by Riel Miller in the Futures Literacy UNESCO Knowledge Labs (FL Uknowlab) or Local Scoping Exercises (LSE), held by UNESCO in 2013 in a range of countries, e.g. Germany, Norway, Brazil, Columbia, etc. See, e.g. [*Miller et al.,* 2013].

Figure 1. **Operating in both Known and Unknown Systems**



Source: adapted from [*Miller*, 2007; *Miller*, 2011a; *Miller*, 2011b].

when monitored — enables one to adapt to new events or situations along the way. Here beyond looking 'inside-in' (within known systems) it enables one to look both 'inside-out' and 'outside-in' the system under analysis. In other words, it enables one to identify how changes in the system being analysed (therefore known, at least partially) can impact other systems and vice versa. Innovation promoted here is also incremental but with the potential to foster more radical or disruptive innovation.

Being able to embrace complexity and uncertainty, however, means putting a stronger focus on narratives and the ability to reframe (questions, concepts, cultures, etc.) our images and metaphors about the future. According to Miller, this means that the future is not detached from the present but is an alternative intrinsic part of it, which enables us to embrace the 'unknown' and the unexpected in the present while the future unfolds [*Miller*, 2011a; *Miller*, 2011b]. The focus is on more than one transformative future ('outside-out') that is open to discontinuity as well as to birth and rebirth. In the end, such an approach allows for both incremental and radical or disruptive innovation, with experimentation being at the heart of our capacity to cultivate and reap the new and the unexpected [*Miller*, 2011a; *Miller*, 2011b].

Based on the above, the direction in which foresight is evolving at CGEE aims to enable the institution to operate at of all the above-mentioned systems in parallel. In doing so, it invites uncertainty, complexity and creativity throughout the process and translates these into actual recommendations for policy design and implementation or into new strategic questions that should be investigated and addressed to reorient the Brazilian NIS. F

Aulicino A.L. (2006) *Foresight para políticas de CT&I com desenvolvimento sustentável: Estudo de caso Brasil* [Foresight for STI policies for sustainable development: Evidence from Brazil], São Paulo: Tese (Doutorado em Administração) – Departamento de Administração da Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo.

Bach L., Matt M. (2005) From economic foundations to S&T policy tools: A comparative analysis of the dominant paradigms. *Innovation Policy in a Knowledge Based Economy: Theories and Practises* (eds. M. Matt, P. Llerena), Berlin: Springer, pp. 17–40.

Bariloche Foundation (1976) *Catastrophe or New Society?: The Bariloche Model*, Ottawa: International Development Research Centre.

Barré R., Keenan M. (2008) Revisiting foresight rationales: What lessons from the social sciences and humanities? *Future-Oriented Technology Analysis* (eds. C. Cagnin, M. Keenan, R. Johnston, F. Scapolo, R. Barré), Heidelberg: Springer, pp. 41–52.

Bergek A., Jacobsson S., Carlsson B., Lindmark S., Rickne A. (2008) Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*, vol. 37, no 3, pp. 407–429.

BNDES (1984) *Scenarios for the Brazilian Economy through 1990*, Rio de Janeiro: Brazilian Development Bank.

Buarque S.C. (1998) Experiências recentes de elaboração de cenários do Brasil e da Amazônia brasileira [Experiences of developing scenarios for Brazil and the Brazilian Amazon]. *Parcerias Estratégicas*, vol. 1, no 5, pp. 1–26.

Cagnin C., Keenan M., Johnston R., Scapolo F., Barré R. (eds.) (2008) *Future-Oriented Technology Analysis — Strategic Intelligence for an Innovative Economy*, Heidelberg: Springer.

Cagnin C., Loveridge D., Saritas O. (2011) FTA and equity: New approaches to governance. *Futures*, vol. 43, pp. 279–291.

Cagnin C., Amanatidou E., Keenan M. (2012) Orienting European Innovation System towards Global Challenges and the Roles FTA Can Play. *Science and Public Policy*, vol. 39, pp. 140–152.

Cameron H., Loveridge D., Cabrera J., Castanier L., Presmanes B., Vazquez L., van der Meulen B. (1996) *Technology Foresight: perspectives for European and international co-operation (report to DGXII, CEC)*, Brussels: European Commission. eScholarID: 5b550.

Cuhls K. (2003) From Forecasting to Foresight Processes — New Participative Foresight Activities in Germany. *Journal of Forecasting*, vol. 23, pp. 93–111.

Da Costa O., Warnke P., Cagnin C., Scapolo F. (2008) Foresight's Impact on Policy-Making: Insights from the FORLEARN Mutual Learning Process. *Technology Analysis and Strategic Management*, vol. 20, no 3, pp. 369–387.

De Jouvenel B. (1963) *The Art of Conjecture*, New York: Basic Books.

Edquist C. (2008) *Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures)* (CIRCLE Electronic Working Paper Series 2008/06), Lund: Lund University.

Eriksson E.A., Weber M. (2006) *Adaptive Foresight: Navigating the Complex Landscape of Policy Strategies*. Paper presented at the Second International Seville Seminar on Future-Oriented Technology Analysis, Seville, 28–29 September.

Fagerberg J., Mowery D.C., Nelson R.R. (2004) *The Oxford Handbook of Innovation*, Oxford: OUP.

Freeman C., Soete L. (1997) *The Economics of Industrial Innovation* (3rd ed.), London: Pinter.

Freeman E. (1970) Stakeholder theory of the modern corporation. *Business Ethics — Readings and Cases in Corporate Morality* (4th ed.) (eds. M. Hoffman, R.E. Frederick, M.S. Schwartz), New York: McGraw-Hill, pp. 184–191.

Gabor D. (1964) *Inventing the Future*, New York: Alfred. A. Knopf.

Georghiou L. (2001) *Third Generation Foresight — Integrating the Socio-Economic Dimension*. Paper presented at the International Conference on Technology Foresight "The Approach to and the Potential for New Technology Foresight", Tokyo: NISTEP. Available at: http://www.nistep.go.jp/achiev/ftx/eng/mat077e/html/mat077oe.html, accessed 22.04.2014.

Georghiou L. (2007) *Future of Forecasting for Economic Development*. Paper presented at the UNIDO Technology Foresight Summit, Budapest, 27–29 September.

Glenn J.C., Gordon T.J. (2008) The Millennium Project – Futures Research Methodology, V2.0. Available at: http://www.millennium-project.org/millennium/FRM-v2.html, accessed 14.09.2013.

Hall B.H., Rosenberg N. (2010) *Handbook of the Economics of Innovation*, Amsterdam: North Holland, Elsevier.

Havas A., Schartinger D., Weber K.M. (2007) *Experiences and Practices of Technology Foresight in the European Region*. Paper presented at the UNIDO Technology Foresight Summit, Budapest, 29–29 September.

Hekkert M., Suurs R., Negro S., Kuhlmann S., Smits R. (2007) Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change*, vol. 74, pp. 413–432.

Jacobsson S., Bergek A. (2006) A framework for guiding policy-makers intervening in emerging innovation systems in 'catching-up' countries. *European Journal of Development Research*, vol. 18, no 4, pp. 687–707.

Johnston R. (2002) *The State and Contribution of International Foresight: New Challenges — The Role of Foresight in the Selection of Research Policy Priorities*. Paper presented at the JRC-IPTS Seminar, Seville, 13–14 May.

Johnston R. (2007) *Future Critical and Key Idustrial Technologies as Driving Forces for Economic Development and Competitiveness*. Paper presented at the UNIDO Technology Foresight Summit, Budapest, 27–29 September.

Keenan M., Butter M., Sainz de la Fuenta G., Popper R. (2006) *Mapping Foresight in Europe and Other Regions of the World: The 2006 Annual Mapping Report of the EFMN*, European Foresight Monitoring Network.

Massari G. (2013) Relatório final sobre mapeamento das atividades de prospectiva no Brasil [Final Report on Mapping Foresight Activities in Brazil], Brasília: Centro de Gestão e Estudos Estratégicos.

Meadows D.H., Meadows D.L., Randers J., Behrens III W. (1972) *The Limits to Growth*, New York: Universe Books.

Miller R. (2007) Futures Literacy: A Hybrid Strategic Scenario Method. *Futures*, vol. 39, no 1, pp. 341–362.

Miller R. (2011a) Futures Literacy — Embracing Complexity and Using the Future. *Ethos*, no 10, pp. 23–28.

Miller R. (2011b) Being without Existing: The Futures Community at a Turning Point? A Comment on Jay Ogilvy's "Facing the Fold". *Foresight*, vol. 13, no 4, pp. 24–34.

Miller R., Garrido Luzardo L., Nosarzewski K. (2013) *Using the future to think about local labor markets* (Report of a Futures Literacy UNESCO Knowledge Lab (FL UKnowLab), Bogota, Columbia, 25–26 November, 2013). Available at: http://www.worldwewant2015.org/file/432846/download/471144, accessed 16.02.2014.

OECD, Eurostat (2005) *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data* (3rd ed.), Paris: OECD.

Papon M. (1988) Les chevaux du pouvoir [Horses Power], Paris: Plon.

Porto C. (2012) *Prospective Foresight in Brasil: An Overview and Cases*. Paper presented at the Mutual Leaning Workshop on Scenarios, 5 December, CGEE, Brasília.

Rattner H. (1979) *Estudos do futuro: introdução à antecipação tecnológica e social* [Future studies: Introduction to anticipating technological and social changes], Rio de Janeiro: FGV.

Rogers E.M. (1995) Diffusion of innovations (4th ed.), New York: Free Press.

Salles-Filho S. (2003) Política de Ciência e Tecnologia no III PBDCT (1980/1985) [Science and Technology Policy no III PBDCT], *Revista Brasileira de Inovação*, no 01/2003, pp. 407–432.

Santos D.M., Fellows Filho L. (2007) *The Role of Foresight Experience in the Promotion of Brazil's National Innovation System*. Paper presented at the Technology Foresight Summit 2007 on Water Productivity in Industry, Budapest.

Santos D.M., Fellows-Filho L. (2009) Prospectiva na América Latina: Evolução e desafios [Foresight in Latin America: Evolution and Challenges], Bauru, SP: Canal6.

Sardenberg R.M. (2001) Brasil 2020 — Semana Brasil 2000. Discurso proferido pelo Ministro da ciencia e Tecnologia, Embaixador Ronaldo Mota Sardenberg, Sesseo de Abertura da Semana Brasil 2000. Paris, 16 de outubro de 2000. *Revista Parcerias Estrategicas*, no 10 (marco), pp. 18–35. Available at: http://www.cgee.org.br/arquivos/pe_10.pdf, accessed 10.08.2006.

UNIDO (2005) *UNIDO Technology Foresight Manual* (in two volumes), Vienna: UNIDO.

Van Dijk T.A. (1991) *Racism and the Press*, London: Routledge.

Van Lente H. (1993) *Promising technology, the dynamics of expectations in technological development* (PhD thesis), Twente: University of Twente.

Von Hippel E. (2005) *Democratising Innovation*, Cambridge, MA: MIT Press.

Weber M. (2006) Foresight and Adaptive Planning as Complementary Elements in Anticipatory Policy-Making: A Conceptual and Methodological Approach. *Reflexive Governance for Sustainable Developmnet in VoB* (eds. J.-P. Bauknecht, R. Kemp), Cheltenham: Edward Elgar, pp. 189–221.

Wells H.G. (1901a) Anticipations: An Experiment in Prophecy. I. *The North American Review*, vol. 172, no 535, pp. 801–826.

Wells H.G. (1901b) Anticipations: An Experiment in Prophecy. IV. VI. War. *The North American Review*, vol. 173, no 538, pp. 401–412.

Wells H.G. (1913) *The Discovery of the Future*, New York: B. W. Huebsch.

Woolthuis K., Lankhuizen M., Gilsing V. (2005) A system failure framework for innovation policy design. *Technovation,* vol. 25, no 6, pp. 609–619.