Science and Technology Foresight: Provocateur for Innovation Policy?

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S&T Foresight: Provocateur for Innovation Policy?

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Abstract

The paper reviews recent experiences in Canada designed to engage Federal and Provincial departmental policy authorities in a broad, long term and interdisciplinary consideration of prospective impacts of S&T innovation possibilities and scenarios. Focused on key public policy domains such as health, economic development, security, environment, energy, food safety and transport, the Office of the National Science Advisor has supported the development of a nascent collaborative foresight capability across the federal government that seeks to influence the framing of S&T related policy domains so that they can be more cognizant of emerging developments and better prepared for potentially transformative technologies and applications that appear to be transcending traditional policy boundaries. In this context of promoting a new capacity for forward anticipation beyond the normal 1-5 year governance time frame, foresight can be regarded as a potential provocateur for innovation policy framing. The paper analyses this experience to date and derives some lessons for foresight and policy practitioners.

I. Introduction

In 2001-02 the National Research Council of Canada initiated a new capability for examining the emerging horizons of science and technology in the context of a set of tools and approaches that are derived from foresight experiences around the world.

This new Office of S&T Foresight was given a mandate to explore how foresight as a flexible, multi-disciplinary and technology based approach, could add perspective and additional S&T awareness to the policy processes associated with federal S&T, R&D and funding allocations in support of Canada's longer term innovation horizons and opportunities.

Since 2002, the Office has facilitated eight collaborative projects spanning a wide range of technical domains and subject areas. In each project, federal policy authorities from the key sectors affected – health, natural resources, economic development etc. have been participants and often contributing partners.

The Office of the National Science Advisor (ONSA) was created in 2004 after an absence of some 30 years, during which S&T advice was primarily left to the various science based Ministries and Departments. Understandably, the dominant emphasis for federal S&T during this period was on resolving single agency based issues, negotiating interface issues through non science focused central agencies, and largely advising on policy and regulatory choices from within existing policy-domain boundaries.

Diagrams 1 and 2, below reflect the new mandate for the National Science Advisor. Diagram 3, lists the key mandate elements for the Foresight component of the ONSA.

Diagram 4 defines foresight as a flexible and forwardly provocative series of key societal lenses or perspectives.

Diagram 1

Diagram 2

Diagram 3

Diagram 4

This paper will review the eight project areas and briefly evaluate the impacts and learning processes that can be discerned from the different engagement levels and institutional responses that the foresight activity has prompted. The overall objective of the paper is to outline some of the key factors, cautions and lessons learned from applying foresight, and its relatively long term time horizons and strategic considerations, to the complex factional dynamics of interdepartmental policy systems, which tend to be short term and transactional in character.

Finally the paper concludes with some observations about how foresight might strengthen and improve its provocative effectiveness, for the benefit of more robust policy capacity.

II. Eight Horizon Derived – Policy Envelope Pushing Domains

The eight domains listed below represent a compilation of projects organized by two successive organizations: from 2001-2004 as the NRC Office of Technology Foresight (NRC-OTF) and from 2004-2006 as the S&T Foresight directorate of the Office of the National Science Advisor. The author headed both of these organizations, and the transfer of functions was part of the establishment of the National Science Advisor's new mandate in 2004. The significance of this transfer will be referenced later in the paper.

The eight domains and their policy reference areas are summarized in Table One below:

Table One: Foresight Projects and Policy Areas

Project Topic	***Description***	***Relevant Policy Areas***
1. Bio-Systemics (BIOSYS)	Systemic implications for biotechnology evolutionary scenarios and their impacts on traditional "stove pipe" policy lenses	Health, security & defence, natural resources, economy, environment, social
2. Geo-Strategics (GEOSTRAT)	Strategic directions and capabilities of emerging location based geo-information systems and their hardware architectures	Security & defence, transport, natural resources, commerce
3. Bio-Health Stewardship & Innovation (BHSI)	Technology impacts from novel and integrative bio-technologies and their impacts on public and private health innovation, management and delivery	Health, innovation and commerce, social, environment
4. Bio-Products Industrial Economy (BPIE)	Scenarios and policy measures for advancing preparedness and positioning of sustainability enhancing bio-based products	Environment, social, transport, energy, health, economy.
5. Animal & Human Health Foresight (AHHF)	Scenarios and disease-pandemic readiness measures to enable animal optimization and create effective human threat mitigation	Food inspection, health, environment
6. APEC Future Fuels Foresight (AFFF)	Technology roadmaps and scenarios for the replacement of conventional hydrocarbon fuels with unconventional ones, bio fuels and hydrogen-fuel cells and other novel technology alignments	Energy, economy, environment, trade
7. Understanding Converging Technologies	Identifying and elaborating technologies emerging from bio-info-nano and collaborative design origins that have	Biotechnology, health, social, energy, environmental, energy,

Foresight (UCTF)	distinctive converging and integrative characteristics and their ethical questions	R&D granting
8. Prospective Protective Security Futures (PPSF)	Applying S&T Foresight to all hazards and public safety risk assessment and the S&T development challenges to ensure strategic and operational readiness	Defence & security, social, privacy, innovation-R&D, emergency preparedness

The outcomes from these eight topics have provided a background against which policy authorities have been challenged to think ahead, to consider multiple, plausible and contingent pathways that their future assumptions and present directions could be surprised by change, or altered by new developments.

How is this done? The next section briefly outlines the foresight methods that have been applied in most of these topic areas.

III. Foresight as a Provocative Place Setting for Policy Planning

Diagram 5 describes a typical typology for assigning change factors from the readily observable to the unanticipated.

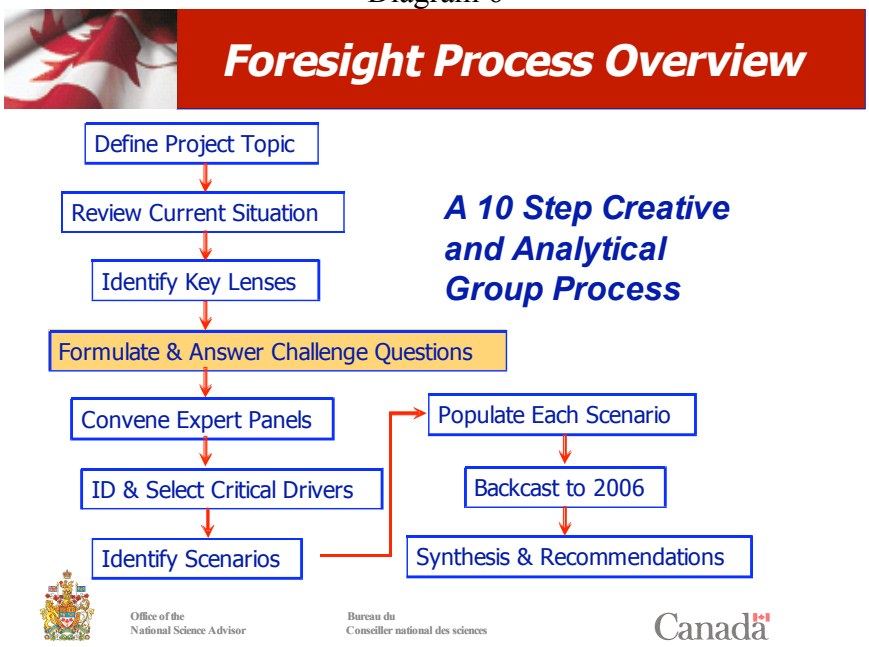
Diagram 5

In approaching foresight, situating the present and its vulnerabilities is a critical first step. Most foresight processes follow a two-pronged approach that combines developing some

consensus or alignment around the most critical drivers-uncertainties with a diverging set of scenarios designed to capture the effects of trends, drivers and shocks in multiple boundary conditions for prospective policy challenges. Participants are then challenged to back-cast from these scenarios to derive policy recommendations and inflection points where strategic decisions could have enabled or altered policy directions and outcomes.

Diagram 6 below, outlines foresight steps that are taken to elaborate the detailed application of foresight methodology to broad policy issues.

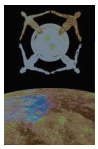
Diagram 6



The challenge at each step is to frame the questions and the *what if* foresight measures so that policy issues and implications, especially in terms of critical choices that will shape diverse futures are clearly evident and that those representing policy authorities acknowledge this. Effective foresight requires that each participant partakes as an active player rather than being a passive observer or spectator.

As an example of how foresight extracts technical possibilities from the environment of leading edge science and emerging technology, Diagram 7 illustrates some potential applications derived from the Bio-Health foresight for the area of tissue engineering within the two time horizons of 10 and 20 years.

Diagram 7



Tissue Engineering

Widely used in 10 Yrs	Ten years & beyond
• Human skin • Artificial blood, kidney, liver, nerve cells, synthetic bone • Cells for targeted detoxification • Probiotics , prebiotics Nutraceuticals in food	• Molecular pharming of wide range of large therapeutic molecules (proteins, lipids, enzymes, etc.) • For wide range of diseases (cancer, heart, stroke, diabetes) • in-body drug manufacture

IV. Foresight Influencing Policy: A Continuum of Capability

A starting point for the analysis of prospective impact is how we view the context of the principal economic and social policy expectations held for government performance. Diagram 8, below describes the complex relationships that typically govern this broad performance measure. To disaggregate the ultimate goal of a high and sustainable quality of life, with its implied continuous augmentation of our societal wealth creation capacity, we can identify five key forms of innovation capital. These include the major public functions of education, environmental protection, R&D supported risk sharing and the social institutions and network efficiencies made possible by public infrastructure investments. They can also be thought of as foresight dimensions of public interest since they represent recurring policy challenge areas that clearly affect societal opportunities and national competitive challenges when viewed from and international perspective. We shall come back to these innovation domains in examining the ways that foresight to date has been able to address the thorny questions of linking insights to future value prospects and proposals for innovation preparedness.

What differentiates foresight from policy may be principally the time-urgency and choice requirements; what unites them is their joint commitment to strengthened awareness and decision making by having better intelligence about prospective impacts of public actions.

Before advancing too many assertions about the nature of foresight contrasted with policy, it may be useful to suggest that not all policy is created equal. Some policy is highly prescriptive and regulatory based or deployed. Other policies tend toward the domain of strategy where resilience and agility are valued, and positioning is more important than consistent alignment.

The policies that foresight can influence tend to be those that are the result of collective learning processes and-or choices that are arrived at through sense making dialogue with stakeholder communities. What is relevant for this interface is that policy and foresight are both situated along a spectrum of actions that governments can invest in to guide their interventions and supports to other players in the society, as they contend with economic, social, environmental and adaptive skills challenges. So returning to Diagram 8, both foresight and policy approaches are typically required to ensure optimal societal performance. At the level of supporting effective innovation systems elements, foresight is important for anticipative awareness and policy is important for directing strategic resources to growing the sources of capital needed to succeed.

Following this line of complementarity further, Diagram 9 provides a more succinct overview of the linkages between foresight and the national innovation policy system. Here the focus is not only on the supports foresight can accord to public functions, but also how foresight is a necessary asset for helping private innovators contend with longer term intelligence and readiness for change in global competitive environments.

Diagram 8

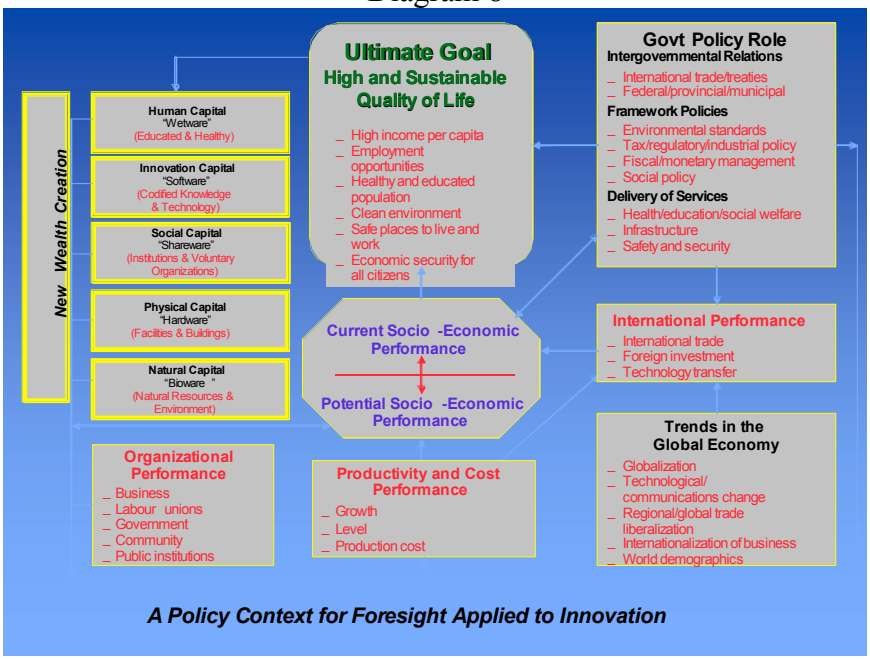
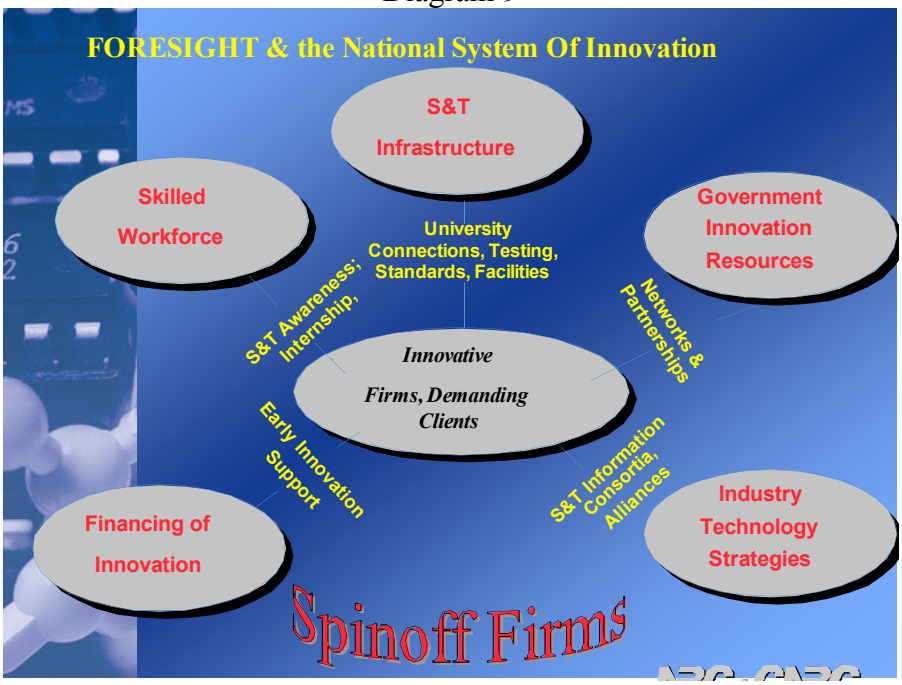


Diagram 9



Below Table 2 lists a range of near term impacts that we estimate the application of foresight has made on the Canadian federal policy process and infrastructure. Chief amongst these is probably the foresight replicating structures being introduced within some of the major Ministries and Departments. If nothing else these allocations of resources, additions to mandate and recruitment of talent suggest that these organizations do not themselves want to be surprised by similar research and collaborative activity elsewhere, whether from Central Agencies or other line agencies. On a more positive note, there is now a loose community of foresight practitioners across the federal policy system from which a more robust capacity for new foresight investments can be expected. Considering the small scale and modest funding levels associated with Canadian federal foresight, these estimated impacts are not inconsiderable.

Table Two: Foresight and Prospective Policy Impacts

Project Topic	*Observable-Short Term*	*Potential – Long Term*
1. Bio-Systemics (BIOSYS)	Recognition by EC-EU R&D Framework planners as original contribution to EU Knowledge Society discussions; lead into broader definition of health, resource and	New alignments of disciplines and the catalytic role of biotechnology as an organizer of human

	defence forward policy scanning and categorization of innovative S&T phenomena.	adaptive capacities broadly within ecological systems
2. Geo-Strategics (GEOSTRAT)	Support for policy initiatives by Geo sector of NRCan to accelerate strategic investments in federal geo-spatial data infrastructure management and more coordination, links to wider policy array	Vision for future of geo-spatial data utility articulated, and commercial, Canadian potentials described
3. Bio-Health Stewardship & Innovation (BHSI)	Health Canada established a new unit for biotech regulatory foresight; SARS pandemic scare seen as exhibiting small world emergent networks structure; direct advice from industry obtained on barriers to commercial innovation in health system	Major opportunity identified by a cross section of stakeholders for Canada to lead world in adaptive, technology and patient enabled health and disease prevention
4. Bio-Products Industrial Economy (BPIE)	Guidance from knowledgeable stakeholders group about how to tie pragmatic bio-products development to issues and opportunities associated with rural communities viability, green energy, innovative environmental systems products and processes; several Provinces and some communities moving ahead to define green development strategies	Prospects for diversified bio-products strategy as sustainable substitution for many inefficient industrial practices; source of economic revival for selected rural communities
5. Animal & Human Health Foresight (AHHF)	Food safety and disease outbreak practices now can be managed more proactively with animal optimization and human health protection both as key policy pillars	Clear case for widespread introduction of new monitoring and response technologies
6. APEC Future Fuels Foresight (AFFF)	Forum for strategic awareness and Canadian source validation of advice on off-oil options accessible for hard hit oil dependent APEC economies	Roadmaps and scenarios developed that highlight long term Canadian assets for energy partnerships
7. Understanding Converging Technologies Foresight (UCTF)	Recognition by EC-EU Commission on Converging Technologies for European Knowledge Society; path breaking work to define a National Dialogue on convergence with several Provinces, Federal agencies and industry partners	Prospects for lead in developing technology niches; innovative opportunities to address enduring Canadian assets management issues and challenges – eg water.
8. Prospective Protective Security Futures (PPSF)	DRDC and others recognizing importance of foresight as critical for new Public Safety Departmental capabilities	Likely formative role for foresight in supporting PSTP Vision 2015

V. Elaborating the Foresight - Innovation and Sector Policy Interface

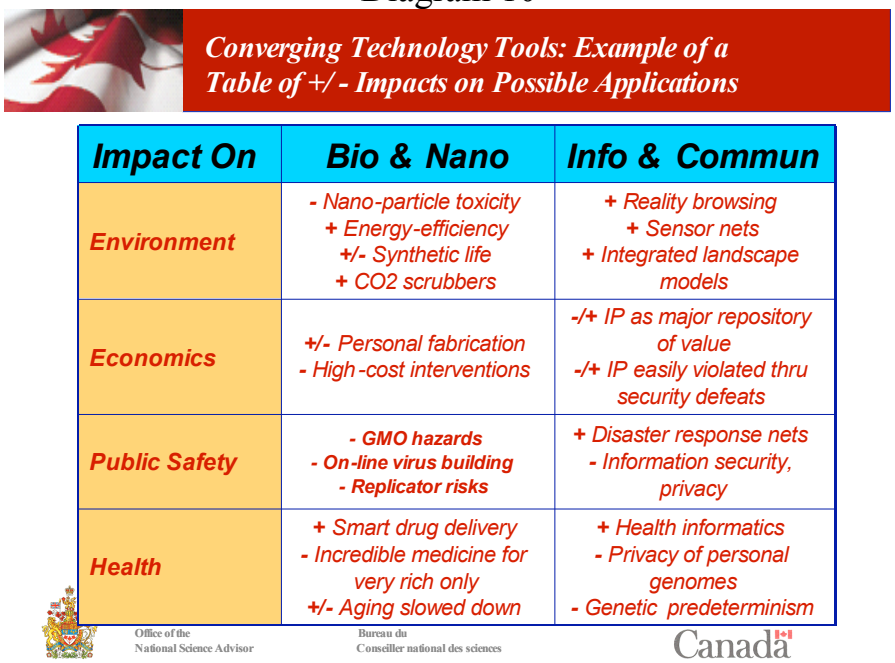
Table Three portrays the relative role of foresight and policy activities as mediated by strategic functions within a government context. As foresight methods become more robust and the bank of useful exercises and practice is extended, and as the policy enterprise becomes more comfortable with simulation, modelling and mapping tools, the distinction grows weaker and the main differentiator becomes the time frame and application of findings. Foresight typically is carried out looking ahead 5-25 years, while policy tends to focus on the 1-5 years.

Table Three: Foresight and Policy Contrasts

Attributes	***Foresight Character***	***Policy Character***
Time Horizon	5-25 years	5-55 months
Range & Scope	5-10 scenarios, pathways	3-4 options
Data Focus	To describe emerging signals, indicate relative magnitude	To validate current and projected domain trends
Sources	Outside-looking in scans, drivers identification, *what if* models, scenarios and weak signal literature-web reviews of new and emerging trends, technologies & linkages	Inside-looking out studies, landscape models, pilots, statistics, cost and stakeholder impact projections
Key Tenets	Multiple, plausible, contingent perspectives, described in rich stories	Comparative analysis of relative robustness, evaluated for impacts
Outcome	Objective then normative and non preferential	Objective then normative and preferential
Benefit	Provides alerts and early warning signals for adaptiveness – thereby helping seed readiness and positioning for future policy choices	Ability to make choices and focus activities on currently or near term productive domains

Diagram 10 summarizes some of the early insights that the ONSA-STFD foresight project on Understanding Convergence is raising for foresight exploration to anticipate prospective applications and impacts. These are also likely to be substantive policy generators during the next 5-10 years within the sector-policy categories noted.

Diagram 10



VI. Conclusion and Lessons Learned

Foresight should be seen as a useful learning tool for policy researchers, as a forward planning and exploration asset for policy advisors and as a context setter for policy makers. By identifying early alerts and emergent developments, foresight can provide necessary agility that enhances the resilience and robustness of policy framing, and can expand the range and robustness of policy options. In a world where innovation has become more intense, faster, global in scope and more technologically dependent, the broadly based insights that foresight examines help create agility and preparedness which in turn can be highly effective as inputs to innovation policy.

From the experiences of conducting the eight foresight projects listed above emerge several lessons for enabling and strengthening these important linkages;

1. Start from a collaborative base of several complementary partners;
2. Use adequate preparatory and dialogue tools to ensure clarity of purpose, alignment on expected outcomes and consistency with long term policy motivations where these are evident;
3. Involve policy advisors and researchers early in the scoping of the topics;
4. Ensure that senior policy authorities are informed about the process and the results;
5. Build in a significant amount of communications early and as follow up to ensure the important findings and learning is received by stakeholders;

6. Set clear rules such as: require policy participants to be as actively involved as all the others- no spectators, no mere analysts, no individual attributions of ideas, and seek explicit commitments to integrate foresight into policy framing discussions;
7. Designate a principal client for each foresight – ideally a senior decision maker-receptor that also has policy responsibilities.
8. Be adventuresome and boundary pushing, using experts and challenging them to reach beyond their normal comfort zones;
9. Be alert to the popular policy drivers and societal anxieties that may intensify as more and better information becomes available, and seek to focus foresight to provide this if applicable;
10. Employ the best gaming and simulation tools that can be afforded – these are rapidly developing into the most capable tools for complex modelling and dynamic understandings of impacts.
11. Structure foresight panels to involve a diversity of players that is at least equal to the diversity expected for policy analysis and stretches even further in age range to enable youth perspectives a stronger voice – since it is their future that is being discussed.

With these insights in mind, and because foresight pushes participants to contend with plausible, contingent scenarios, and evaluate their prospective policy implications, it is our proposition that foresight can be a valued provocateur for innovation policy.