

SCIENCE & TECHNOLOGY FORESIGHT

Learning from Technology Foresight Connections

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“The future cannot be predicted, but it can be invented.” Dennis Gabor

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Abstract

Since 2002, the Office of Technology Foresight (OTF) at the National Research Council has been developing networks of knowledge, interest and influence to provide new strategic capabilities for Canada’s S&T organizations. Each step of this process has involved some iterative learning and tools refinement.

In the course of this work, which has involved over 350 S&T professionals and teamwork in the design, creation and adaptation of foresight techniques, templates and methods, the OTF has succeeded in creating a web of affiliated professionals working to further Canada’s broader S&T strategy. As an example, work in BioSystemics foresight during 2002/2003 led to the development of an extended network of experts to create an information architecture and a foresight project in 2004 on Bio-Health Innovation and Stewardship. This foresight area is closely aligned with the priorities of the new federal innovation policy aimed at encouraging Canada’s future bio-economy.

The paper examines the foresight techniques, templates and organizing strategies that the NRC OTF applied to build the connection webs necessary to influence this policy agenda. The paper will focus on the following elements.

- Methods for the identification of experts, stakeholders, and influence targets;
- Choices and factors for technology selection and assessment;
- Factors and choices in scenarios definition and elaboration;
- Templates design for scenarios guidance and development;
- Communications vehicles for connecting members of the network beyond events participation;
- Connections with policy leaders and stakeholders outside the foresight arena.

The paper concludes by drawing some observations and lessons from a deeper understanding of the critical variables in creating foresight value within complex policy and strategic choice networks.

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I. Introduction

When leading a country on behalf of its citizens, governments are responsible for looking ahead to avoid real dangers and to take advantage of opportunities, in the short-term and just as importantly, in the long-term, by developing the necessary thinking to anticipate change and plan for surprises. By taking a forward-looking view to meet the challenges that are to come, while negotiating external and internal forces, governments are better prepared when they can reduce uncertainty and increase strategic options available to them and their citizens. Since opportunities are not easily apparent when staff members are entrenched in the daily administration of departments and long-standing paradigms, national governments require strategic and corporate policy groups to focus on foresight initiatives in an interactive real-time way.

Government foresight operates predominantly at the national level to identify possible directions for technology and science programs by informing the decision-making process of strategies that may benefit policy in the future. Foresight attempts to broaden the perception of an organization and challenge assumptions through a deeper level of learning and understanding of complex systems, by focusing on uncertainties, analyzing trends, and exploring driving forces and risks, with an eye always to the future. Making better strategic decisions and more agile and anticipatory plans in a rapidly changing world is the goal, not to predict the future.

Instead, influencing present day actions and decisions, including funding, and setting priorities on vision building, is key in a world that is changing so fast that it has made the rational planning approaches that many organizations use ineffective, because they are based on the tenets of relative stability over a relatively long period of time. The goal of foresight and contingency planning is to develop a range of prospective, plausible or possible futures that an individual or organization may have to contend with using both analysis and imagination in a systematic way. The overarching aim is to build a better quality of life through being prepared to see the opportunities for meaningful innovation.

II. World of Change and Surprise

In a world that is full of surprises, it is increasingly important for nations to incorporate contingency planning and preparedness capacities, while breaking down the boundaries that limit perceptions. Technological innovation is accelerating at a rapid pace on a global basis, and science continues to play a fundamental role in shaping international foreign policy and global trade, along with competitive practices. Over the past twenty-five years, the challenges of the HIV/AIDS epidemic, the end of apartheid in South Africa, an increase in terrorism, the explosive growth of the Internet, the Human Genome Project, and the end of the Cold War all took place. Most recently, the economic fallout from SARS for Canada was unexpected and costly.

The following provides a summary of several factors currently causing global tension and societal uncertainty:

Societal Change Drivers

- Demographics -- population changes
- Science & Technology -- knowledge & innovations
- Environment -- carrying capacity, global ecology
- Attitudes, Values, Beliefs -- from opinion to religion
- Global Economy -- interdependent markets, trade
- Governance & Institutions -- political organization
- Evident Threats -- to civilization & infrastructure

Obviously, security and adaptability matter a great deal in a world where governance mechanisms and institutions are undergoing rapid change, with technology transforming everything from our communications systems to how we buy airplane tickets. Although Canada has not had a regular forum for societal or S&T focused foresight, using it to increase the resilience of Canada's S&T readiness and to learn how to better anticipate the unexpected is a logical and cost-effective investment, given the inevitability of major surprises resident in a complex globalized world. S&T Foresight relies on correctly interpreting S&T change drivers, and the causal and temporal factors involved with change when it comes to Canada's future social, economic, and political realities. It is therefore, a highly analytical and speculative exercise that incorporates imagination and creativity to a large degree.

Macro Shaping Trends

- Integration, Miniaturization of Technology
- Globalization of Trade, Capital, Terror
- Harmonization of Standards, Protocols
- Migration, Multi-Culturalism of Populations
- Intensification, Differentiation, of Wealth
- Bi-polarization of Religious Values and Secular Evolution
- Transformation of Infrastructure Systems
- Virtualization, Digitization & Integration of Business Models, Communications, Entertainment, Education
- Automation and Customization of Production
- Acceleration of Knowledge Services as Economic Driver
- Proliferation, Adaptation, Rapid Circulation of Disease

Major Uncertainties Surround

- Individualism versus community
- Sustainable development dynamics
- Outward-looking communities versus isolationism
- Financial market consistency and performance
- New diseases, viral spread, containment
- Access and use of weapons of mass destruction
- Consequences of global warming
- Impact of changing fertility rates

III. Project Origins

To anticipate a variety of plausible developments, innovations and disruptive technologies that could cause major shifts in the social and economic environment represents a necessary flexibility-enhancing investment. This was the conclusion of Canada's Deputy Ministers in March 2002. With the science content of policy issues increasingly

encroaching departmental boundaries and a need for horizontal cooperation becoming more of a necessity, it was clear to the Ministers that the development of some new tools for longer term forward thinking and the identification of strategically important issues should be a priority, if the country was to be better prepared and able to get the most out of federal science investments and reduce or at least prepare for significant risks, even possible disasters. Surprise is one of the givens in a world made up of intricate and complex interactions. What we do with that reality will make an incredible difference in the future.

This was the context underpinning the development of the interdepartmental Science and Technology Foresight Pilot Project (STFPP) carried out during 2002-2003, which originated with a proposal made by NRC to the community of federal Science Based Departments and Agencies (SBDAs) in March 2002. This pilot project was designed to begin building a better capacity for anticipating or at least understanding the context for the kinds of surprises that our society may have to contend with sooner than many think.

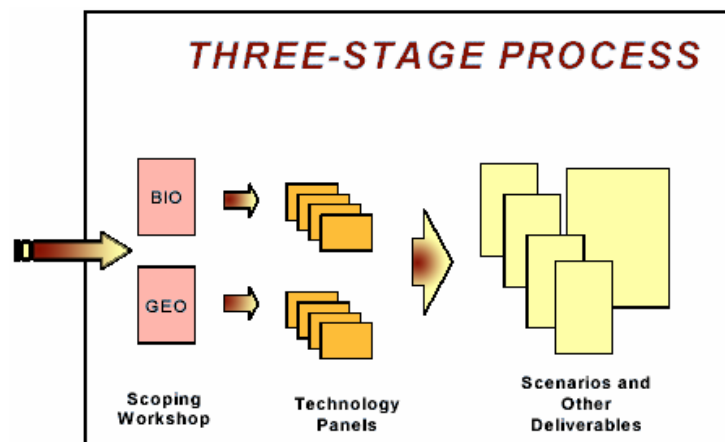
Participants were urged to accept that the world is both complex and ambiguous, and to understand that stability is not the best defence against uncertainty. Encouraging them to give their ideas free rein, they were told that, "Scenario planning is not about certainty, but about imagining real possibilities. Bring us your possibilities."

The project involved thirteen Canadian federal Departments and Agencies in an exploration of S&T foresight planning strategies with a view to better understanding some of the longer term, integrative and horizontal challenges and opportunities that the federal S&T community might have to cope with, looking ahead to 2015 and beyond. The topics were selected to be far enough away to be outside most current investments, but close enough to resonate as more than science fiction. Stimulation of longer term thinking, the building of shared R&D awareness to initiate a network to foster consensus and collaboration, and the ability to engage in broader challenges were key goals of the pilot project. Other aims included the creation of a futures discussion framework, and bringing together Canadian and international experts to strengthen communication. A few key foresight tools were used in the pilot project, namely:

- **convergence literature review**
- **topic scoping**
- **technical experts panels**
- **scenario planning**
- **web conferencing**
- **R&D thematic identification**

After several months of collaborative discussion and design, and foresight topics solicitation, examination and selection, the STFPP was formally launched in October 2002. The objective as articulated by the Inter-Departmental Working Group was to explore the use of foresight to identify some prospective R&D opportunities in the present day, and to benefit from and prepare for disruptive technologies that may be coming down the pipeline.

An innovative and adaptive process emerged for the Pilot Project from a collaborative design initiative by the foresight project participants. It is a three-stage process consisting of the following project phases:



IV. Identification of Experts, Stakeholders, Influence Targets

Many different methods were used for the identification of experts, stakeholders, and influence targets, with equal consideration given to both researchers and policy experts. From the outset, the STFPP had an additional goal in mind, beyond the pilot project: the establishment of an informal network of long-term thinkers within Canada and elsewhere. A network made up of several hundred people, who could be counted on to provide skilful quality contributions and show real interest by volunteering time and expertise. A key challenge for the project leaders was the majority of participants had little or no prior experience with S&T foresight, scenario planning or similar tools, but agreed to learn through doing it.

The multi-faceted approach used for the identification of experts included:

1. Surveying the literature in search of experts to contribute to the process.
2. Asking around for experts.
3. Identifying stakeholders through domains of interest.
4. Following the money trail to determine who has both the necessary funding and an interest in the process.
5. Asking senior people who should be involved. The more people with different viewpoints who participate in a foresight project the better.
6. Identification and nomination of experts by the SBDAs for each of the two topics, including referrals from the private sector, university and international experts for consultation.
7. Participants were also found through a Community of Practice that was set up to: locate experts; grow and manage a network of peers; facilitate collaboration and communication; and share knowledge, such as best practices, via a secure web access.
8. The Scoping Workshops also presented opportunities for the identification of individuals who could play a role in future foresight consultations and/or scenario planning events.
9. The second phase of the Expert Topic Panels brought together a wider array of experts in the sub-sector technical areas to provide specialized and general input to the project in the form of contributions based on their experiences and knowledge for each of the chosen topics, and provided us with an important resource of possible participants for the scenario exercises.
10. Networking can put you in touch with high-quality and interesting participants, who can provide insight from the fringes.
11. Meetings and conferences

V. Factors in Technology Selection and Assessment

The multi-step topic selection process to choose two key technology sectors for the pilot project took over two months to complete, in part due to scheduling difficulties, and differing degrees of organizational motivation and enthusiasm. The focus was on identifying topics that could:

- be applied realistically to S&T and R&D policy, and investment strategies;

- influence change and yield the greatest economic, environmental and social benefits over the next 10-25 years;
- and very importantly, be capable of addressing significant areas of concern for each of the departments participating, allowing for collaboration and an improvement in horizontal cooperation and a deeper understanding of stakeholder concerns.

Step 1 - Topic Submission and Ranking

All participating departments and agencies were asked to submit up to five topics for consideration as possible candidates for the foresight process, using a list of criteria and associated questions to guide them.

Criteria	Questions
Criteria 1: Federal and Canadian Leadership	Is federal leadership appropriate for this topic? Is anyone else in Canada poised to assume a leadership role? Where does Canada stand in terms of its international competitors in its ability to affect or benefit from developments in this area?
Criteria 2: Strategic Interest, Uncertainty, and Time-horizon	Is the topic likely to be highly influential in affecting S&T, R&D choices, economy or society? How many departments' and agencies' strategic affected? Is the level of uncertainty high enough and the time-horizon warrant predicting diverse outcomes through S&T foresight?
Criteria 3: Significance & Impact	How clearly can the potential impact of this issue or topic be estimated? What impacts on policy development, public good or society can be expected? What are likely to be the impacts on R&D, business, the economy and industry?
Criteria 4: Feasibility of carrying out foresight on this topic	Would we be able to draw on Canadians or would we need significant international expertise? Does Canada have the critical skills/disciplines that would be needed to carry out this pilot foresight? What are the expected costs for doing this work, and what prospects exist for contributions from industry or others?

After this exercise, nearly forty topics were sent to the Interdepartmental Working Group (IWG) for further examination and tested for appropriateness. A selection of these is listed below.

A Range of Prospects	
Sustainability science	Climate change from space
Remote environmental sensing	Sustainable manufacturing
Metabolemics	Intelligent robotics systems
Technology convergence/genetics	Space for environmental security
DNA-based early systems	Biomass energy
Advanced power systems	Changing northern environment
Microbial ecosystems	Space-enabling technologies
Remote diagnosis/diseases	Biodiversity/invasive species
Personalized medicine	Canada's sea floor
Biotechnology	Virtual ocean
Human global health/environment	Proteomics/economy, health
Predictive modelling	Space Surveillance and National Security
Security/Info systems, networks	Intelligent Autonomous Systems
Integrated nanotechnology	Clean hydrocarbons
Regenerative medicine	Sensors/Activators – health

Step 2 – Topic Refinement and Selection

Project participants were then contacted by members of the IWG in order to discuss and confirm their submissions as a first step in the refinement process for topic selection. In order to look for similarities and remove duplications, items were subsequently categorized according to **S&T Platforms** (i.e. - Remote Sensing, Nanoscale & Convergence, Bio-Tech/Genomics, Robotics/Integrated Systems, Modelling/Simulation, and Transformative Energy Systems) and **Issues** (i.e. - Security & Protection, Climate and Environment, Health System Development, Sustainable Systems, Special Environments, and Socio-Economic Adaptation), and put into a cross-matrix grid. Grid items containing three or more topics were highlighted as having a high level of relevance and seen as possible candidates for the project. Of these, those appearing more inclusive, with a high level of interest for SBDAs, and presenting manageable boundaries for foresight applications were given extra points, especially if a shared technology platform or alignment of issues was found to be present.

On the basis of potential convergence opportunities, the list was narrowed even further, giving extra importance to those judged stronger by small teams of experts, who used a series of convergence topics as benchmarks. The top ten topics were then reviewed by the NRC and the IWG in an effort to arrive at consensus on two broad and inclusive topics for S&T foresight. The two chosen topics were further refined as a result of feedback and consultation with experts from participating departments and agencies. An expert responses questionnaire was then used to further develop the scope of the project by having individual SBDAs answer four questions, using the two pilot topic summaries as a point of departure. See the following table for the Expert Responses Questionnaire.

Expert Responses Questionnaire
In the context of the broad definition of the topic, what do you regard as the key uncertainty factors, drivers of change and challenges that are likely to require new S&T capabilities, competences?
Are you aware of relevant reports, panels, conferences or long-range studies that have addressed these topics with a time range 10-25 years?
What additional sources of knowledge, or factors should we consider to assist the S&T Foresight exercise broaden its thinking outside the usual disciplines – e.g. complexity theory, cognitive neuroscience, anthropology-sociology?
Who domestically and internationally could or should be consulted or invited to participate to deepen or extend our knowledge on the topic and how could they best contribute?

The two topics of Bio-Systemics and Geo-Strategics were selected for the foresight exercise for several reasons:

- Leaders in advanced infrastructure technologies, such as the US National Science Foundation and the National Reconnaissance Office, are also exploring convergent technologies.
- Most of the more narrow topics submitted by individual SBDAs fell under the umbrella of at least one of the chosen topics.
- Contrasting challenges and opportunities are presented, one oriented towards applications and engineering, with the other more science determined.
- The expertise of several partners could be enlisted and stretched.
- Neither was directly replicating existing planning domains.

The two topics also represent two ends of the traditional S&T spectrum, while offering prospects that reach beyond most present configurations. Each is also capable of presenting systemic opportunities and offers a view to the bigger picture.

Subsequently, meetings took place to develop a detailed Work Plan and to assign management tasks around the two broad topics chosen for the pilot project, along with task of identifying appropriate experts for each topic. Agreement and authorization was also needed on the acquisition of resources, including monetary funding, and on methodological approaches, project milestones, and deliverable dates.

VI. Factors and Choices in Scenarios Definition, Elaboration

Over two hundred individuals, including those from federal government departments and agencies, universities, and industry, took part in a series of scoping workshops, technical panels, meetings during November- December 2002 in preparation for a synthesis of technical findings and a web conference. These were all inputs to the March 2003 Scenarios Workshop. Additional focus was given to the broad themes of Bio-Systemics and Geo-Strategics to map out future S&T drivers for each, and as a way to identify potential significant events. The Project Team used their review of the scoping, technical and synthesis reports as the basis for the creation of ten thought-provoking stimulus scenarios. Each scenario included a mix of options for technology and research to meet the end-state developed by the process, and outlined what efforts are needed to meet that end-state. The goal of the Scenarios Workshop, as set out in the Workshop Workbook, was:

To create a set of well-grounded yet thought-provoking scenarios, integrating the knowledge, experience, and imagination of our diverse attendees. We are laying the groundwork for establishing long-term technology foresight capability in Canada.

In March 2003, an intense two day scenario workshop convened in Ottawa, attracting a wide range of S&T policy, industry, academic and international experts and stakeholders. Participants were broken into ten groups and each group was given a unique one page starting point that was an informative, enticing, and thought-provoking description of a scenario. The ten suggested or stimulus scenarios covered a wide range of potential situations, including aspects of utopias and dystopias, and formed a well-distributed sampling using drivers, such as security, technological advancement, social capital and intentionality, environmental factors, and other key high-level observables that define the state of our world.

Each group of 8-10 people were expected to elaborate and explore their world from a variety of perspectives, adapting the narrative, and developing detailed relevant scenarios that highlighted the uncertainties and driving forces relevant to strategic decisions facing an organization or country. Each was also expected to offer policy advice that could be useful in understanding S&T and policy contingencies when looking ahead to Canada as it might be in 2025. While acknowledging the “imagination” elements of the workshop, the seriousness of the process was emphasized, by asking participants to link innovation and creativity to survival, along with encouraging the realistic development of contingent future situations.

The goal was to construct a self-contained world that respected the small set of axioms suggested in the initial one page description, and to explore what the implications of that world would be, from a variety of analytical perspectives. Scenario builders were not only expected to draw upon their imaginative and creative abilities, but also use analytical and evaluative methods in linking scenarios back to the present. Finally, the Project Team designed a process of taking constructed scenarios and creating a list of resonant themes, which enabled the identification of stimulating R&D and policy implications for Canada today. The objective was to develop lists of prospective projects which could be applied collaboratively and horizontally across departments, and ultimately develop into strategic R&D investments involving more than one government department or organization.

The factors and choices used in scenarios definition and elaboration were numerous and included:

- **Domain Prospecting** – Convergent Technologies: what are the emerging areas of great uncertainty and how are they developing, especially in relation to common or convergent tendencies?
- **Disruptive and Enabling Technologies** – the exercise revealed a number of potentially disruptive and /or enabling technologies that could have far more impact than many would imagine at present.

- ***Policy Backcasting*** – how can we work backward to infer key actions and technologies that led to your scenario (include advice and initiatives adopted by government and industry). Generate a backward-flowing network using whiteboard and poster templates.
- ***SWOT Brainstorming*** – what are the areas of significant Strength, Weakness, Opportunity and Threat that should be identified as being critical for the scenario?
- ***Technology Trend Synthesis*** – can a consistent trend with clear or at least discernible impacts be identified from the review of all technologies that are thought to affect the scenario?
- ***Contingency Models and Comparative Scenarios*** – how broadly can you make scope for the scenarios, can a few models be developed and compared to understand what is robust through several or all of them, in terms of areas of desired preparedness?

VII. Scenario Templates

The following templates and steps represent a further elaboration of this approach. These indicate how a recent 2004 Foresight on Bio-Health Innovation and Stewardship addressed the scenarios development process.

Step 1 – Building Your World

Each participant will be assigned to a team with a scenario. The first step is to get acquainted with other members and get a common understanding of how you would further describe the world you have been assigned. These have been very loosely defined to give you latitude to enhance it.

Try to define some basic characteristics. Is the scenario good or bad? Does it overly rely on new technology or a transformation of social attitudes? Is it managed from the top, or organized from the bottom up? Later we will be considering policy implications. Ask yourself what issues society might need to address in your scenario.

Step 2 – Change Drivers

Once you have an idea of what your world looks like, identify the drivers that will push us into your world.

What's a driver? In a world of cause and effect, it is the cause. Drivers can be characterized as trends and dynamics which have momentum (such as population growth). They may also be 'tipping points' which, once passed, release a latent trend (such as climate change or environmental degradation). Drivers may have momentum themselves, such as population growth. The whole discussion about the nature of drivers can get complicated. We will keep it simple. Use Post-it notes to capture your thoughts about drivers. Then, lay them out in the familiar STEEP categories used in environmental scanning.

Make the following distinction between your drivers:

- Are they baseline assumptions? These describe the context of your world that is 'pretty sure' to occur. They can include ideas about population size, likely technological progress, form of government, and social attitudes.
- Scenario 'What If?' assumptions are the wild cards or deviation from the norm that make your scenario unique. These can be things like the release of a man-made virus, or the rapid progress of a new technology.

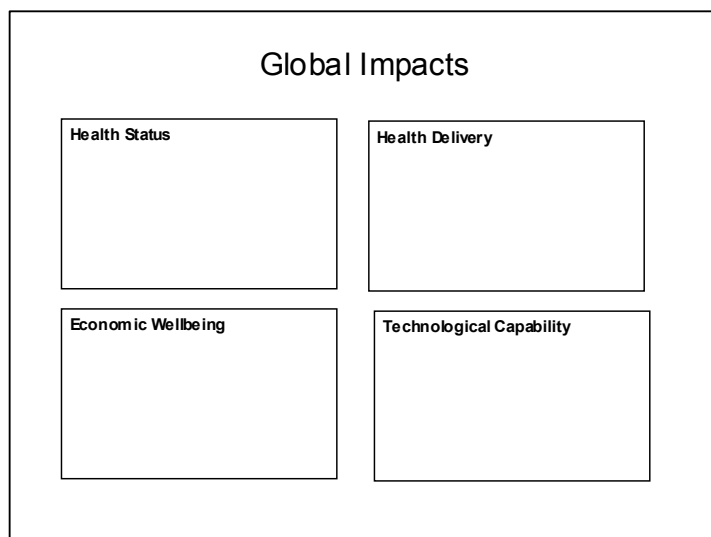
Keep track of relationships between drivers. Some may be valid in an international, but not domestic, context. Some may operate in a virtuous circle.

Step 3 – Global Impacts

As a next step, consider the implications and impacts of the drivers you have identified.

The template suggests looking for impacts on four variables:

- Health Status – just how healthy are we?
- Health Delivery – by what means do we deliver health care?
- Economic wellbeing – are we better off? Does the health system contribute to economic wellbeing or is it just too expensive?
- Technological Capability – is technology helping us out or is it just a diversion away from real health issues, such as a quality environment?
- You may want to add a further category covering social cohesion: are the drivers strengthening social harmony or creating social difference and discord?

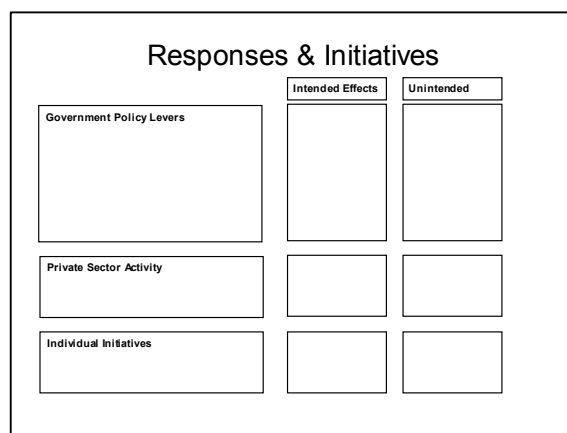


Note that these are just suggested impact categories. You may, as a group, wish to define other categories, such as ethics or the implications for risk management. If so, go ahead, but try to keep it in the realm of Bio-Health innovation. Look at the big picture. Look at Canadian issues in the context of a global health environment.

Step 4 – Responses & Initiatives

In this step, take a look at some of the possible human interventions that will either amplify or attenuate the effects of the drivers. Nothing happens in a vacuum and over the space of 15-20 years a lot of human tinkering can be expected.

In most scenarios the government will likely be the key player. It does heavily influence major health resourcing decisions. But private organizations will play a big role in R&D, too. In some scenarios they may be major vehicles of health care delivery. Individuals may also play a role, particularly when it comes to ‘wellness’ strategies. Certainly, a composite of Individual Initiatives produces a public *reaction* which may be positive, neutral or negative to the intended initiative. You should be considering big instruments here, not system tinkering such as R&D, Regulatory, Health system uptake and Health industry commercialization, public confidence, etc.

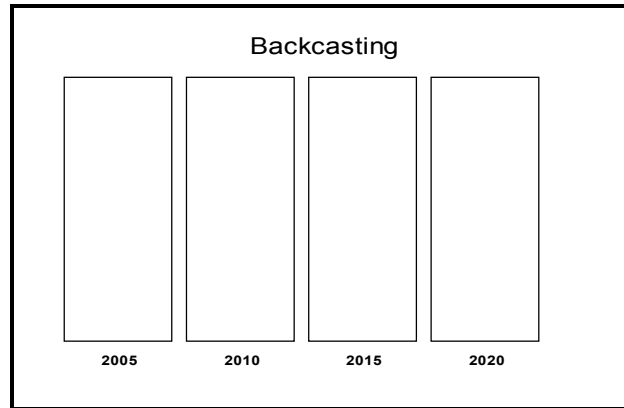


When you have a reasonable list of actions, take a look at possible consequences of the actions, staying within the context of the scenario. Look for both intended consequences and any interesting unintended consequences.

Step 5 – Backcasting the Trajectory

Step 5 is a reality check. Take the previous work on drivers, impacts and responses. Try to build a path between the present and the future. What events have to happen between now and the future in order to bring about your scenario. Consider the full range of government responses – funding of R&D, applying tax or procurement levers, regulations, assessment of technologies, and health technology assessment or uptake practices.

Line up events in chronological sequence and see if they ‘make sense’ -- are plausible.

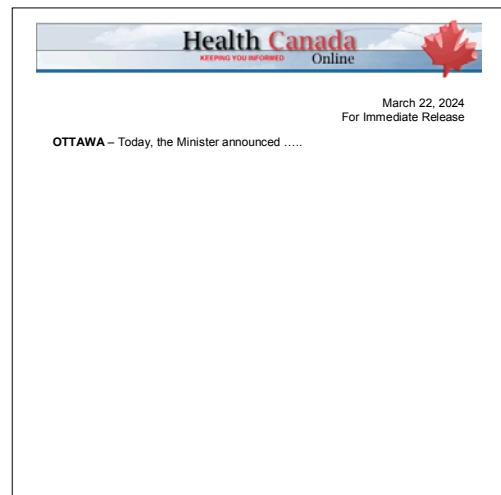


Step 6 – Write a Draft Scenario for 2020

Pull all of the elements together into a story line dated sixteen years into the future. Try putting it in the format of a press release announcing some new policy or initiative. Describe:

- The current situation (as of 2020)
- How we arrived at that situation
- The challenge faced by government, business, or ordinary Canadians
- The decisions taken
- The program undertaken
- The huge benefits Canadians can expect

Do this in a bulleted list format. We will have the opportunity to draft the scenario in narrative format later. As for the unintended consequences, hide them, but do not forget about them. They will have a way of surfacing later in the “Meet the Inquisitor” activity.

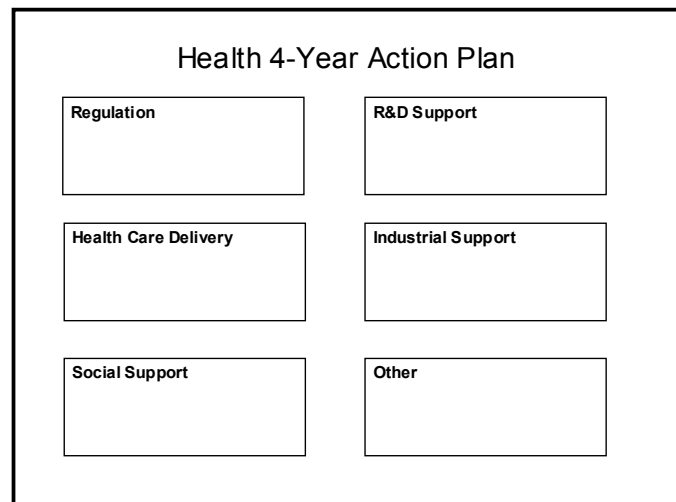


Step 7 – Health Sector 4-Year Action Plan

Now, collapse the future into the present. Suppose that you knew, with 100% certainty that your scenario would come to pass. Following the path outlined in the Backcasting exercise, what would you do today either to ensure that the positive outcome was achieved or to prevent an unfavourable scenario from coming about?

The template for this step suggests categories of action that reflect some of the main policy levers. If other categories are better for your scenario, feel free to change them.

- Regulation could include not only regulation of drugs and devices, but also things like safety, quotas, foods, and metrology.



- R&D support would include government, industry, and academic institutions. It may also have an international component.
- Health care delivery should look at all aspects, including public/community health initiatives.
- Industrial support would consider issues relating to procurement, grants, and demonstration projects.
- Social support could include general wellbeing, infrastructure (clean water), education, and access to counselling and expertise.
- Other – there are many possibilities, the environment being one.

Consider the roles of all players: government, business, academia, and private individuals. Please remember that Municipalities play an important role, especially in wellness actions and emergency response activities. Who does what, when, and how?

Step 8 – Present-time Action Plan

Put together a brief (five minute max) presentation to the plenary in flip chart format, describing the essence of your scenario and what it would mean in terms of today's decisions. Remember, you have 100% confidence in your scenario. What needs to be done today to set us on the path to this future?

Step 9 – Meet the Inquisitor

Just for fun, we will randomly select an inquisitor who could be:

- Technology Critic
- Eco-Protectionist
- Industrialist or Entrepreneur
- Government Regulator
- Science Journalist

They will ask some tough questions!

VIII. Connecting Network Members Beyond Events

- **Email lists** are used quite extensively to keep the pool of experts and stakeholders updated on upcoming events, conferences, and meetings.
- **Monthly meetings** of the Interdepartmental Working Group play an important part of the communication strategy.
- **Conferences** are great communication tools, and are used extensively to keep in touch with network members.
- **Email newsletter** -- a web-enabled e-bulletin of selected sources and drivers for emergent technology foresight developments and related global activity was launched in December 2003. *Foresight Contingencies* delivers select sources of information concerning Technology Foresight, with some analyses.
- **Regular Internet Website** -- S&T Foresight website: <http://www.techforesight.ca> provides access to a number of reports, and notices for upcoming events. This relatively new website is currently under design.
- **Community of Practice Website** Internet Agora for S&T Foresight: <http://agora.scitech.gc.ca/foresight> was created a few years ago by NRC to facilitate collaboration, enable communications, and disseminate information amongst present and future project participants, and other interested parties. It allows for secure web access to both reports and discussions, and is not generally accessible to web search engines, nor is it listed on the NRC home page. Provides access to S&TF Pilot Project knowledge without the need for a password or requirement to register to view or download research reports.

- **Web Conferencing** is a highly cost-effective future strategy that can be used productively for focused questions, real time and asynchronous brainstorming and for Delphi polls from time to time. It was one of the tools used in this foresight event, and although it did not necessarily attract high numbers of participants because of time constraints, it certainly should be explored again in the future. The draft research reports on the two topics were made available to registrants and they were asked a series of leading questions concerning future directions. All participants of the Technical Panels and Scoping Workshops for the two topics (Geo-Strategics and Bio-Systemics) were invited, along with a selection of members from an international virtual brainstorming community, as well as other S&T analysts and authors. It can be password protected and is easy to use.

IX. Connections with Policy Leaders, External Stakeholders

Foresight planning does not follow any prescribed process and is not easily accessible to those on the outside looking in, but its power lies in the ability to significantly change the mental models of those involved and establish new ways of thinking creatively across organizations, which is in and of itself, a positive outcome. Involvement and commitment of decision makers is critical, and foresight exercises must be regarded as important and endorsed by senior public officials, who otherwise may view them as a waste of time and resources. A key question remains: How do we present the methodology to people not actively involved in the process?

Since foresight is a contact sport of sorts, if stakeholders are not present, it is much more difficult for them to understand the importance of the exercises, and sometimes even more difficult to get additional funding from them in the future. Time must be devoted to networking with policy leaders and stakeholders outside the foresight arena, and consideration given to the dissemination of reports, allowing for feedback from all stakeholders. Creating scenarios that are plausible and meaningful encourages cooperation and spreads interest. Scenarios should be designed in such a way as to allow all stakeholders the ability to understand the new world you are creating, and be relevant enough to excite. This will go a long way in developing a receptive culture, inspiring imaginations and challenging conventional wisdom.

One of the many mistakes that can be made when trying to communicate scenario results to top officials is forgetting that the recipients are most often not involved in the process and therefore, did not benefit from the learning experience. Given that so much of the insight and learning comes from participating in a foresight event, identifying and measuring success to stakeholders is very difficult, and almost impossible, except in the very subtle ways in which participants see the future differently. It is important for this kind of impact to be noted as time goes by because it provides insight into a very extraordinary event and communicates meaning.

Most importantly, the findings should be presented with great care and in a way that is relevant to organizational strategies and goals, with clearly defined next steps included. A crucial element of the communication process lies in how much consideration is given them by those not present and how much action is taken as a result. Scenarios should powerfully impact stakeholders, especially those who were not able to participate in the creation of them. That can only take place if there is an investment in scenario communication, a very challenging task. How you will communicate the deliverables for any exercise should be included in the goals from the outset and reiterated over the months to make sure all stakeholders and decision makers are fully briefed. Presenting the findings in an objective and inclusive manner, with testimonials and analyses of implication can help a great deal.

Conceptualizing foresight exercises is crucial for the development and maintenance of strong relationships with decision makers, and also plays an integral role in the creation of champions among them. Cultivation of a champion from the outset is a key to success and should be a goal of the leaders; someone who commands respect and promotes the process to those within the organization and to those who have substantial power to command change. The STFPP included the top players from participating departments and agencies in the initial research process, and they were responsible for the topics used for the project, thereby stimulating strategic conversation from inception and helping to avoid future allegations of short-sightedness.

Another best practice is to interview senior management and policy leaders at the commencement of foresight activities to ensure that the decisions you are making will resonate with their experience and are relevant to the work they do. Significant results are possible, but only if the top players see the process and end results as integral to the organization's goals and offering direction for future change.

Including a wide range of people from diverse interest groups is also important when you are endeavouring to make connections with policy leaders and stakeholders outside the foresight arena. This will help to reduce future political impediments and possible misunderstandings, since if a wide range of stakeholders from all major interest groups are included in the process, there should be more mutual respect and understanding. If that's not possible, bring stakeholders in at various points to test reactions and integrate feedback.

The communication of scenario outputs is a crucial aspect but always a challenging one, especially when influential decision makers and key players are unable to participate in an actual workshop. Using experienced and polished speakers to present the information is a good strategy, as is publishing the scenarios in interesting and professional ways, choosing colourful names for the scenarios to go along with stimulating storylines.

With a big enough budget, you can role play a scenario, or create short films, as well as crafting other innovative and interactive events that will invite participation and present the scenarios to all stakeholders in a very desirable and informative manner. Use any method that will present the scenarios in the best light, making them more tangible and plausible.

X. Lessons Learned For Foresight Practice

From the perspective of the Project Leader there are many lessons learned and many areas for improvement. A summary comment is:

It would be fair to say that although the STFPF substantially achieved the goals set out by the Interdepartmental Working Group, it could have aimed for more – more engagement, better SBDA alignment, a deeper and more inspiring set of prospective collaborative R&D topics and a stronger resonance with the day to day planning practices of the partner organizations. These remain desirable objectives for the future.

General Observations

- ▶ It is very important to involve as many people as possible in foresight activities – insight and knowledge comes through playing the game, experiencing the choices.
- ▶ It is important to challenge people past their comfort level – facilitators should challenge participants to indicate what could happen, what might be possible, plausible and what would you do if.....?
- ▶ Foresight planning is not about being accurate but imaginative – the goal is capacity development, enhanced intelligence and readiness for a range of multiple, plausible, contingent situations.
- ▶ Contingent capacity is mostly about how to bring challenges to the fore and how to put in place research projects to leverage the adaptive knowledge of large numbers of people.
- ▶ Not all personality types are well-suited to scenario planning exercises – however a robust exercise combines several types of perspectives such as indicated below.

▶ Future Casting Perspectives

- Extrapolation
- Pattern analysis
- Objective goal analysis
- Normative change proposition
- Counter punch and counter-intuition
- Contingency planning
- Scenario competition
- Complex intuition

- ▶ All foresight involves seeking opinions and conducting analyses within a context of significant uncertainty.
- ▶ Foresight creates avenues of communication between diverse groups and fosters consensus – the facilitator should try to coax these diverse players toward cohesion, or at least a well-articulated set of observations.
- ▶ Focused topics, narrowed questions and a more focused clientele can often enable a more effective and efficient scenario development process because less time needs to be spent on context, explanation or negotiation of differing mental models for dealing with uncertainty.
- ▶ Participating in the foresight process is even more important than the end product – foresight is a learning process much more so than a planning tool for precise outcomes or determining operational priorities. It provides strategic perspective.

Planning Event Lessons

- ✱ **In setting the time line for a new foresight process**, especially when serial components are involved, it was determined critical to schedule the events within a close timeframe so as to create and maintain momentum for the project. However ample time between the workshops should be provided to enable the project participants to:
 - Recover from the intense experience
 - Reflect on the intelligence provided
 - Build upon the findings
 - Review and revise the process for quality as it progresses, and
 - Deliver on the reports.
- ✱ **Well articulated and consistent messaging** was determined to be critical for the purpose of properly informing participants of the process and possible outcomes/uses up front. Therefore, it is highly recommended to start the communications process well at the forefront of the process to provide ample time for the development of collateral. In our case, differing levels of expectations existed among the three groups of stakeholders, namely the Deputies; senior managers and staff; and departmental managers and staff.
- ✱ The **registration process** was determined to be a critical and time-consuming task for the Knowledge Managers. Therefore, in planning for future workshops, it is advisable to allow ample time in the process to respond to inquiries and elaborate on process, while engaging and recruiting qualified people to participate in the events.
- ✱ Although the Foresight Pilot Project was to be delivered in a dynamic and collaborative environment, for maximum effectiveness it is advisable to **keep the Working Group and Project Team small** and committed to deliverables. As for the Breakout sessions, it is best to keep the groups small in order to better manage the group dynamics.
- ✱ Lining up speakers for the events was found to be a very time consuming task for the Knowledge Managers. In planning future events, it is highly recommended that an early selection and confirmation process be adopted.
- ✱ The use of NRC staff, as opposed to consultants, could have been a better use of resources, since a lot of time was spent brainstorming and attending meetings. In planning future events, consultant resources may be more effectively leveraged with clear statements of work to define activities and deliverables.
- ✱ Staff assignments and commitments should be formally secured in writing prior to embarking on future efforts, to reduce dependence on consultants and create more internal management capacity;
- ✱ Creating organizational and partner commitment at the outset and ensuring alignment on outcomes and goals is critical;

- ✿ Timing of the financial contributions and the initiation dates for collaborative activities should commence earlier in the fiscal year and provide for bridging capacity otherwise;
- ✿ Effective means are required to enlist senior policy makers as well as S&T staff in being stakeholders for foresight;
- ✿ Efforts should also be made to enlist a greater proportion of youthful participants, perhaps by requiring each senior person to be accompanied by a recent hire. Or integrating students, enabling the exchange of views across age groups.

Management of Foresight Events Lessons

- ✿ Additional work should be done on the methods for managing dialogue for capturing opinion and aligning objectives amongst participants where complex and highly uncertain topics prevail;
- ✿ Project team must work cohesively for joint learning, deliberative discussions and events delivery;
- ✿ Use experienced facilitators, rapporteurs, and knowledge managers to focus events, facilitate and capture system for group dynamics;
- ✿ Templates and flow diagrams for structuring the scenarios and channelling complex discussions toward reportable findings are a must;
- ✿ Scenarios that challenge and engage a diverse group are a prerequisite.
- ✿ A strong delivery model, while retaining its agility and incorporating some ongoing staff and administrative capacity, should be included;

Post-Event Lessons

At the conclusion of the process, there remain several key actions that can be pursued to extend a foresight process in order to capture additional value:

- ✿ Organize 1-2 additional technical experts groups to examine the various findings and propose which areas would deserve further attention, either as “deeper dives” or to reframe some of the topic observations and implications;
- ✿ Explore with partners how a tool such as the Challenge Dialogue System, as developed by The Innovation Expedition (www.innovationexpedition.com) for the Alberta Energy Research Institute would be useful in helping strengthen the prospects for future alignment and horizontal commitments;
- ✿ Re-engage the IWG in a detailed review of the outcomes and lessons learned to develop further the documentation that will be needed to design future efforts;
- ✿ Contact US agencies and foresight leaders to share experience and insights and to see where they are headed next;
- ✿ Complete the consolidation of deliverable research reports as soon as possible and make these available to all participants;
- ✿ Align with the emerging champions for horizontal contingency planning and SBDA horizontal governance to ensure that the foresight experience is neither lost nor ignored.

- More cross-validation of technical findings with diverse groups of experts can add extra value and credibility to the findings which are usually hard for some receptors to assimilate because foresight clearly reaches into the unknown;

Opportunities and Needs for Future Foresight Activities

Looking ahead to the prospect of future foresight activities, a range of opportunities and needs can be identified:

- Build, extend the federal foresight community of practice through more networking and events.
- Support key clients and partners by expanding and deepening these relationships, using the entrepreneurial leverage model.
- Assist communities (e.g. TOP Ottawa, Toronto Research Alliance, Vancouver fuel cells) on technology cluster horizons and long-term foresight scenarios.
- Carry out international foresight monitoring, and learning from best practices, experienced players.
- Develop a Board of Advisors from stakeholder groups to help define the focus and priorities for foresight facilitation inside and outside of the federal government context. A senior forum of advisors could assist with advice on positioning and overcoming obstacles associated with the complex structure of federal S&T.

XI. Conclusion

Foresight planning is an innovative and provocative process, which produces strategic insights, especially for those willing to think outside traditional boxes. Scenarios allow a better idea of the range of futures that are possible, and shed light on the challenges, choices and implications that exist. They can weave together past, present, and future elements and help develop new views of science and technology, and then integrate them into a number of imaginative stories to allow individuals and groups to see things previously unnoticed or acquire new viewpoints on familiar situations. Foresight planning has enormous potential to advance innovation, while focusing on the required next steps and strategic investments needed to move toward preferred futures. Scenarios can be a powerful reminder of the importance and significance of long term policy work in a governmental setting, emphasizing the potential of strategic thinking, and enhancing one's preparation for multiple situations of prospective challenge and opportunity.

In Canada, like many other places in the world, reaction to events is the order of the day, rather than proactive strategies and planning in scientific and technological thinking. We can no longer rely on mental and analytical models that are getting shorter and shorter with each passing year. Organizations that participate in foresight activities can more easily overcome problems and create opportunities and responses that are robust, agile and informed by science and technology knowledge. By using knowledge, imagination, and creativity, we can invent a better future.