Building Capacities and Setting Priorities in National Science and Technology[1]

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ABSTRACT *As governments attempt to reduce the scale of their activities in the face of deficit reduction exercises and improve the efficiency and management of their operations, federal laboratories have not been spared. In many countries, the relative share of government-performed science and technology has declined. Downsizing has thus brought questions of scientific capacity and priority setting to the fore. By taking the case of Canada, this paper explores the meaning of these shifts in resources, re-casts the role of government labs in the public interest, and outlines a recent exercise to use a scenario approach—in lieu of a formal foresight activity—to re-establish mandates and directions.*

Keywords: capacity, priority setting, science-based departments and agencies (SBDAs), scenario building.

Introduction

Whether working within the context of the advanced industrial economies of the OECD, the dynamic emerging markets of the APEC or the transitional states of Central and Eastern Europe, questions concerning scientific capacity and priority setting are implicit in all discussions of science policy. They are both difficult and inescapable.

National debates over knowledge-based growth and prosperity are typically grounded in the capacity of a people to produce, use and diffuse scientific knowledge. Policy debates over GERD/GDP ratios, critical technology lists, or the proper role of government in the performance of science and technology reveal this clearly; and in operational debates, issues over capacity and priority setting are directly linked to how science, research and technological capabilities are viewed as being best organized and managed to contribute to economic growth and social well being.

The scale of a nation's input of resources provides an indicator of this, as does the scope of its activity. Moreover, while debates across countries may seem to be thematically similar, their details in fact reflect the specificity of each national setting. For example, few countries can afford to spend and be active in so broad an array of research areas as the G-5 countries. Smaller countries (that is, 'smaller' in terms of home market size, skilled population base, breadth of private sector R&D performers, and so on), need to continually balance policy between supporting breadth and selecting niches. Canada and Australia both fit into this context, and since so much of the discussion around developing a knowledge-based economy requires not only the production of new knowledge but the capacity to identify, attract, apply and distribute new knowledge, then questions of capacity and priority setting are key.

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Indeed, within the context of the recent re-orientations of public policy in Canada vis-à-vis 'innovation' and the changing roles and mandates of federal laboratories, capacity and priority setting have come to center stage. How did this happen, what does it mean and what are its prospects?

The Re-orientation of Public Policy

By way of background, it is important to appreciate the context for current Canadian policy. Similarities and differences will be evident to international readers. In its 1993 electoral blueprint document, popularly known as 'the Red Book', the Liberal Party highlighted science and technology issues as being critical to its planned economic agenda. It did so through the language of 'national systems of innovation'.

To economists of innovation and science policy scholars, of course, this conceptual framework was well known. The works of B. Ä. Lundvall, Christopher Freeman, and Richard Nelson had already infiltrated the corridors of the OECD Committee on Scientific and Technological Policy (CSTP),[2] but in 1993 this framework was new to policy makers and politicians in Canada.

The path through which this conceptualization found its way into the minds of central agencies was through a network of Toronto-based Liberal 'insiders'. More particularly, this included the Executive Director of the International Federation of Institutes for Advanced Study (IFIAS)—an organization which had funded research into the NIS concept; a Member of Parliament who was a contributing author to the Red Book; and a senior policy advisor to the Prime Minister's Office (PMO).[3]

In February 1994, in the Liberal's first Budget Speech as Government, the Finance Minister enthused—as part of what would become, polemically at least, Canada's move towards being a 'knowledge-based economy' and 'the most connected nation in the world'—that a Science and Technology Review would be undertaken immediately under the leadership of the Industry Minister. By the spring, a series of cross-country consultations by the Secretary of State (Science, Research and Development) had been planned and two volumes of discussion papers had been released, including one on national systems of innovation.[4]

In the same Budget Speech, it was also announced that a Program Review would be undertaken in order to ensure that government department spending was being done in an efficient manner and that duplication of services between departments was identified and reduced. To long time students of science policy, of course, it is perhaps not surprising that by the time the S&T Review was completed and released in 17 volumes 2 years later in March 1996, the dominant principles that had come to drive the Government were the principles of the Program Review, not the S&T Review.[5] In part, this was because:

- the need for a S&T Review was no longer being driven by Central Agencies;
- coordination for the Review was being led by a junior Minister from Industry Canada with no science budget while other Ministers for Environment, Health, Natural Resources, and Fisheries and Oceans were senior Cabinet members with sizeable science budgets;
- Industry Canada (IC) had what could be described as cautious relations with the federal laboratories and science-based departments and agencies (SBDAs) predicated on the perception that IC's agenda was to control the SBDAs;
- the Office of the Auditor General released its 1996 Report criticizing the Government for not setting priorities in its science and technology expenditures;[6] and

- the, by now, dominant governance principles of the Program Review calling for transparency, horizontal coordination, and better management, coupled with the Government's commitment to smaller government and deficit reduction, meant that science spending for both research granting councils and federal labs would not be protected or excluded from the political and policy goals of the day.

One clear message from this exercise, if one hadn't learn it already from the 25 federal science reviews that Canada had undertaken in 35 years, was that science policy cannot be treated as standing outside of the body and practice of public policy making. In and of itself, it does not hold a special place in government circles (unlike scientific knowledge which can still claim to be a privileged type of human knowledge)[7] *unless* it is directly tied to the national interest. Even, or especially, at a time when the production of knowledge itself is being transformed, to miss this point is to risk arriving at a distorted assessment of the science–government relationship.[8]

Conceptual and Practical Implications

What does this shift in language connote? Conceptually, a rationalist's case could be made for the argument that the adoption of a 'system of innovation' language represents a major shift in the government's thinking about science. It could be argued that it represents a deliberate abandonment of linear models of innovation in which 'science push' variants (in which government has a prominent role) and 'technology pull' variants (in which government plays an important role but with more indirect instruments such as R&D tax incentives) prevail. In so doing it could mean a subsequent abandonment of the implicit centrality of research as the engine of economic growth, and therefore of the centrality of government research funding and its performance of S&T.

In its place, the new approach of government—featuring the core concepts of the NIS approach—could be said to feature networks, linkages, learning organizations, and a wide band of knowledge types beyond research (such as tacit knowledge, network knowledge, skills, and know how). It could be said that the new prevalent image features the recognized interaction and importance of all socio-economic actors (not just the government),[9] the importance of partnerships and alliances between actors (and therefore, especially in the case of a small open economy, of the creation of synergies), and of the importance of clusters or 'smart cities'.[10] Each re-jigging of the conceptual framework implies a differing role for government, reducing the centrality of government-led activity (e.g. picking winners) and instead imbedding government into a network of actors ('backing leaders'). Thus governments, in a neo-Keynesian way, can begin to think about providing 'smart' infrastructure (CA*Net3, SchoolNet, Canadian Foundation of Innovation, the Community–University Research Alliances, etc.) which links communities of practice, and designing federal programs which provide incentives for research (e.g. Innovation System Research Network).

Together, this shift in language can be cast as being seemingly in step with both the latest thinking about the research–economy connection *and* a 'devolving state hypothesis' in which, in an interdependent globalized world economy, the sovereignty of nations is in question.[11] Government can thus portray itself as being both 'hip' and responsible. However, such an interpretation may provide something of a *post hoc* rationalization rather than a smooth, government-wide match between what central agency intends and departments understand.[12]

In practice, the adoption of a 'system of innovation' language in government documents[13] reveals less of a break with the proceeding administration's approach to

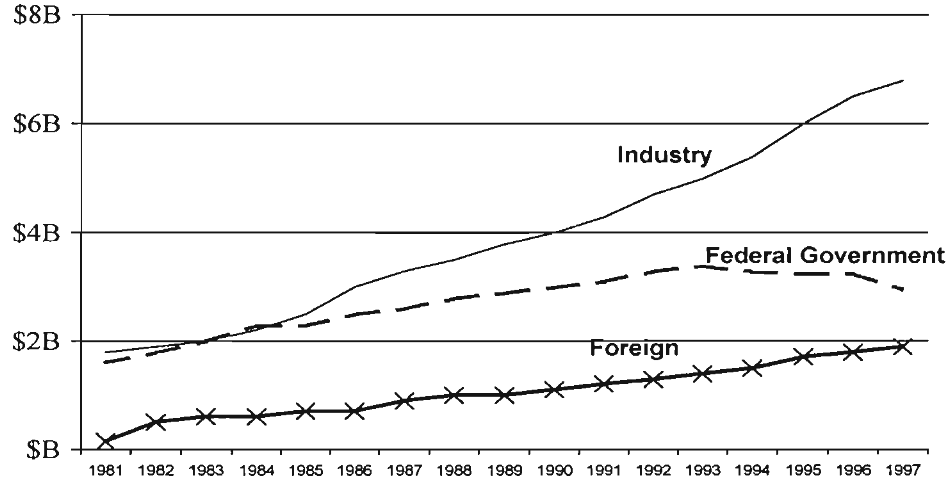

Figure 1. Highly qualified personnel in the federal government. (Selected science based departments and agencies).
Source: Statistics Canada.

science and technology than might be expected, and it has neglected, to some extent, the lost of capacity in the federal laboratory system which began in the mid-1980s. Thus both the *rationalist's* analytic approach fails, as does the *ideologist's* reaction that there is a *de facto* break between Conservative and Liberal approaches: (this only leads us to the complex *realist* pressures of governance). In point of fact, there are considerable continuities between administrations in Canadian federal politics (i.e. there is no 'third way' yet in Canada).[14]

The continuity between the two administrations could be seen in the ongoing commitment to increasing business enterprise R&D through matching grants, the creation of consortia and centers of excellence. It could also be seen in the move to reduce both government spending on R&D and government performance of R&D. However, as Sir Robert May has effectively shown, this is in no way unique to Canada. While GERD/GDP ratios have generally risen in advanced nations between 1981 and 1996, trends in government funded GERD have generally fallen significantly.[15] So, in fact apparent continuities in trends belie less a tacit similarity between Conservative and Liberal governments in Canada than a broad shift in fundamentals, including the agreement to regain control over public expenditures and reduce deficits coupled with all the vagaries implied by an interdependent, globalized international political economy.[16]

Put another way, while industry spending on R&D in Canada has grown from less than $2 billion in 1981 to nearly $7 billion in 1997, government spending began to plateau around $3.5 billion in 1993 and has slipped to $3 billion in 1997 (see Figure 1). Moreover, government budget appropriations for R&D by socio-economic objectives have shown drops, between 1991 and 1996, in non-oriented research, general university funds, and economic development. (Health and environment have shown an increase, even though, as noted below, the budget and resource allocations to Environment Canada have been among the hardest hit by cuts.) In the decade between 1986 and 1997, federal government performance of S&T as a percentage of the total has fallen from 21% to 11%.[17] It is this broad situation that has brought government capacity in S&T into question.

Government S&T Capacity in Question: The History

Within the broad context of the call for 'less government' that was popularized by Gaebler and Osbourne in their *Breaking Through Bureaucracy* and operationalized by the governments of Margaret Thatcher and Brian Mulroney, it is evident that recent years have been quietly typified by a questioning of what the 'proper' role of government is. In science and technology this is certainly true, but the question runs deeper than recent history would superficially suggest. First, while deep cuts have been made, no re-orienting mandate statements have been issued by the Government and departments have been left to 'manage' the decreases. In most cases this has been reactionary in mode rather than strategic (understandably since no one knew where next year's budgets would go).

In terms of science capacity, this has come strikingly to the public eye in a variety of crises. Examples include such issues as 'tainted blood', Hepatitis C, the management of the fisheries, carbon emissions, risk from Radio Frequency Fields, and so on. The underlying public issue (of course, one of many) is whether the federal government can provide fast, high quality science in response to challenges to public risk. (The general concern is that the private sector and the university sectors are incapable or not mandated to respond.)

Going back to the 1970s, in Britain such questions resulted in a (not entirely uncontroversial) set of principles such as 'value for money', project management, user or client re-orientation of labs, etc. that some reticent 'Republicans of Science' still view as being anathema to science.[18] Nonetheless in Canada, similar developments have emerged.

In terms of concern over capacity and priority setting, the Glassco Commission report was able to highlight in January 1963 that 'there is no universally accepted pattern for arriving at these vital S&T spending decisions'. By 1984 the issue had not gone away and the National Advisory Board for Science and Technology noted that 'S&T [were] a clear priority for the government, but [they] were not managed as strategic assets'. By 1990, the Lortie Commission complained that 'outdated and seriously deficient operating and administrative policies' were making it difficult for federal labs to meet expected quality and productivity standards. It noted the emerging low morale in the federal lab system and the need to freshen and clarify lab mandates. (Many of the federal laboratories still operate with mandates written in the 1950s and before.)[19]

On the question of the management of federal labs, proposals have ranged over time from the need for a single federal departmental S&T institute with a CEO and a Board of Directors to a single political 'Science Czar'. Given the mood for decentralization in government, neither of these proposals has ever been seriously entertained.

Both the Lamontagne (1969–1972) and Wright (1985) Reports argued that reviews should be performed to see which aspects of R&D could be contracted out. As Doug Wright said, 'in our view R&D should only be done in-house when there is a need for secrecy or neutrality'. He went on say that there is a need to maintain scientific competence and to maintain contacts with the international scientific communities. 'In all other cases, we believe, the government should attempt to gradually shift the bulk of its research requirements to outside contractors'.

Government S&T Capacity in Question: 'The Threat'

Principles aside for the moment, the result of government action has delivered a government lab system that is under severe stress. This can be seen both in its capacity to deliver, in its ability to set priorities across departments, and focus of mandate in a rapidly shifting environment. This can be seen from an array of indicators. Since 1993, total federal government spending on S&T has fallen (Figure 2). In terms of R&D this has dropped from $2.8 billion to roughly $2.5 billion while related scientific activity has slid to nearly $1.5 billion (see Figure 3). This has been an erosion in both current and constant dollars (see Figure 4). Moreover, total highly qualified personnel in the major SBDAs has dropped from over 35,000 to nearly 28,000 (see Figure 5). This erosion has been felt more deeply in some departments than others.[20] The loss of capacity is felt to be a result of these cuts coupled with a rising existing work load per PY and per dollar as well as of a rising demand by the public in such areas as public health and risk and in such private areas as federal drug approval.

On the more qualitative side, anecdotal evidence from interviews with Natural Resources Canada, Health Canada and the National Research Council[21] shows that some researchers are complaining that they are no longer conducting research; that the research is not being peer reviewed; that they are being told to change research areas by managers because of lost person years (PYs); that they have become contract mangers; that they are being pressured by private sector interests to approve unchecked or un-validated research results; that research careers in government are no longer competitive or viable (so that the demographic curve goes up while uptake into research jobs falls to a trickle); and so on.

Augmenting these suggestions are the facts that government labs continue to have a public responsibility: the public interest (however defined).[22] Despite misplaced arguments about 'market failure', recent work has shown that government labs (a) have been adaptive to changing contexts and environments over time (and therefore there is every reason to believe that they will continue to be so in the future); and (b) have a series of core tasks that cannot be taken over by university labs or industry. These include the following.

- To provide technical assistance to small- and medium-sized Canadian businesses which are working in a technology-intensive area and which do not have the needed in-house expertise or equipment. This is an important role for government which has enabled thousands of firms to grow, compete, and in turn create new value-added jobs. No firm or university could easily provide this service.
- To pursue new technology development in areas such as data encryption where there is both a security issue for Canada (in privacy for example) that will involve government regulatory functions and an economic issue (in CA*Net3 for example) where the future technology can be stimulated in concert with universities and consortia (CANARIE) and in which no one firm could afford to develop in Canada, solo.
- To establish and negotiate standards in order to harmonize Canadian and international regimes to protect Canadians and provide a favorable business climate. Again, state-to-state negotiations cannot be done by firms and government science in the public interest is needed to ensure level playing fields and to avoid conflicts of interest.
- To undertake testing and approval in areas related to drugs, bio-medical devices, vaccines, blood products, and the like which clearly require government involvement as well as a research capability in order to evaluate and verify outside results for the protection of Canadians.

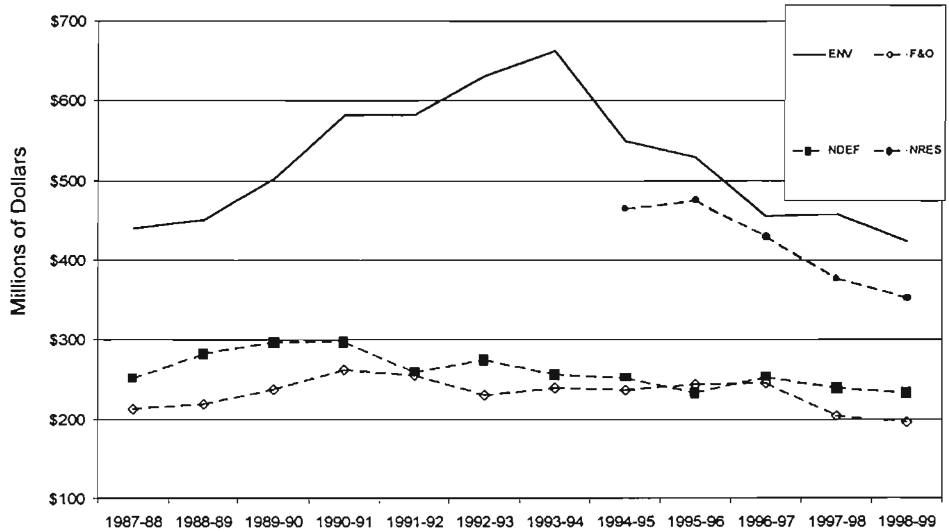

Figure 2. Canada's R&D effort (gross domestic expenditures on R&D (GERD)—Funding sector 1981–1997).
Source: National Research Council.

Figure 3. Total federal government spending on R&D and RSA (major science-based departments and agencies, minus StatsCan and the granting councils).
Source: Statistics Canada.

- To undertake environmental monitoring for the protection of Canada's eco-system and commons (in support of existing environmental standards and in anticipation ofthe identification of new environmental threats). The capacity of the government to carry out such work is critical as ecological threats emerge and as the government commits to meeting negotiated international treaty levels which would be difficult to contract out. Moreover, the capacity to conduct survey work and stock assessments in order to understand changes in the ecological systems of Canada (including the fisheries), geological transitions, and so on are key and are germane to government—not industry—goals and mandates.

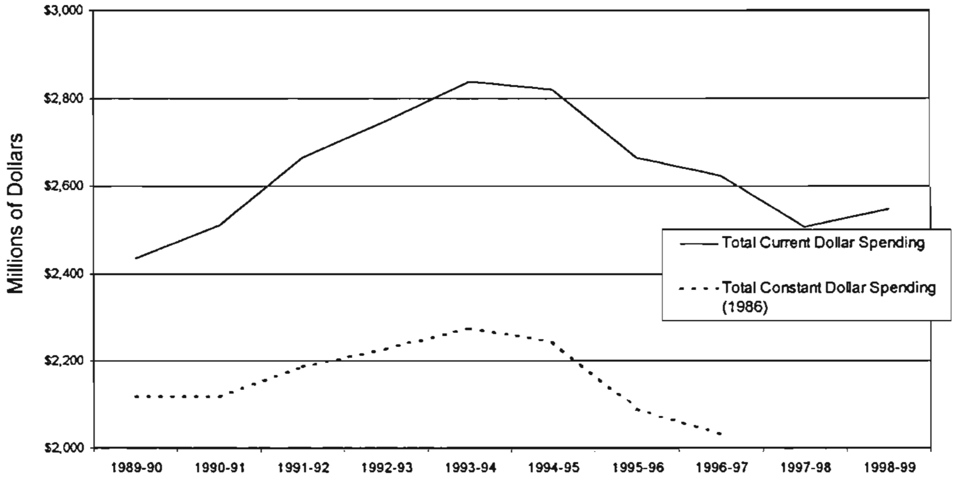

Figure 4. Total federal government spending on R&D (major science-based departments and agencies, minus StatsCan and the granting councils).
Source: Statistics Canada.

- To support emergency preparedness in areas like earthquakes, floods, and the like. Again, firms operating for profit would be hard pressed to undertake earthquake modeling and monitoring over the long haul and Canadians would rightly wonder if emergency preparedness, operated by the private sector, would provide the responsiveness, warning, and universality that Canadians require.
- To support policy in the science-based departments and agencies as well as in industry, heritage, foreign affairs, international trade, defense, and transportation. To farm all these responsibilities out to academic or private sector concerns would not only create a government contract monitoring and management nightmare but could also lead to

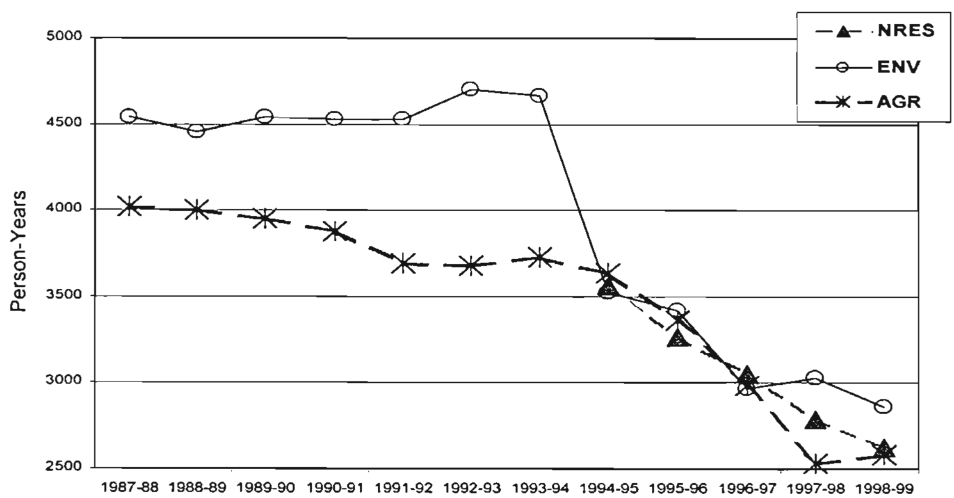

Figure 5. Total federal government spending on science and technology (selected science-based departments and agencies).
Source: Statistics Canada.

breaches of security, a de-coupling of government science from government policy, and a lost assurance that government and the public interest were matched.
- To continue regulatory monitoring and compliance activities such as monitoring and regulatory control of food, drugs, consumer product safety, transportation safety, and the like.
- To conduct basic research, not because government researchers should be expected to contribute to the international open literature, but because basic research will allow government researchers to be involved in the latest developments, findings and techniques, and will keep vibrant an external research network which can be called upon in support of government science. Active research will serve to promote an attractive career path for researchers in which valuable scientific and technical work can be carried out, thus ensuring the revitalization of government science.

This taxonomy of mandated tasks for government science is complex and daunting to manage, but it does lend itself to a differentiation of sectors and incontrovertible government responsibilities in an 'innovation system world'.

Government S&T Capacity in Question: A Scenario Approach

In response to some of the developments noted above, the need for capacity and priority setting work has come to the attention of senior management in Canadian federal labs. This has in large part been driven by the work of the *ad hoc* Science Assistant Depute Minister's (ADM) Committee which represent 13 major departments and agencies.

One concern of the analysts who carried out the study for this committee[23] revolved around the tacit view of some of the SBDAs' managers that the current context of 'lost resources' simply means: (a) that a principle task is to retrieve these resources from the public purse; and (b) to put them back into those same activities which were cut. Instead it was the view of the analysts that following such a route would reinforce the longstanding territoriality that exists between departments and that has in part been responsible for the current situation. Rather, SBDAs should: (c) take the opportunity to seriously evaluate and re-orient themselves, strategically plan and position themselves vis-à-vis their core mandates, core clients *and* the central agencies, and proactively re-tool themselves managerially. In the analysts' view, 're-tooling' and 're-orienting' might well involve horizontal planning and management across the SBDAs (i.e. the creation of a Science Portfolio within government), striking alliances, and building networks and linkages both across government and between government–business–university.[24]

In order to assist managers to move in this direction, 'capacity' in this study was broken into a series of 'drivers':

- scenario description drivers (Table 1);
- outcome drivers (Table 2); and
- implications for capacity planning (Table 3).

In the absence of any Canadian Foresight study of the breadth and scope found in Australia and Britain, this analysis was not intended to replace science capacity planning at the operational level. Instead, it was meant to help managers and policy staff test the robustness of their own capacity plans within a broader planning framework. To achieve this, the study postulated four different scenarios:

- what if the future context of the SBDA is largely as it is today?

Table 1. Scenario description drivers

1. Environment	These are the environmental factors that are driving science policy within the federal government. They include such factors as climate change, global warming and greenhouse gas production
2. Economic	These are the macroeconomic factors that influence the wealth creation status of the nation. These factors influence the economy at large, and thus the total resources available to the economy
3. Industrial	This set of factors describes changes that are or could take place in the government's policies toward industry. These are discussed both in a domestic and an international context
4. Social	These are the social factors that are influencing natural resources policy and S&T within government, or that are being influenced in turn by other factors, such as the economy. Social factors are those which will affect the 'social union'
5. Fiscal	Fiscal drivers describe the government's ability to finance its operations, including its S&T activities. Improving fiscal circumstances may increase the scope for government funding of S&T while a deteriorating fiscal situation will have the opposite effect
6. Policy	These are an amalgam of factors that are driving (or would drive) policy development in the federal government, emphasizing those factors that are influencing science policy: the government's ability to finance and perform S&T
7. S&T	This set of factors relates to the nature and level of the federal government's future requirement for science and technology, and how those requirements might be met; for instance through in-house versus external R&D

Source: John de la Mothe and Ron Freedman for The Impact Group (Toronto).

- what if there is a gradual decline in the resources available for S&T performance across government?
- what if there is an increase in S&T resources?
- what if the future unfolds in a way that is very different from what we are planning for?

Although each scenario was grounded in the contemporary policy environment—in particular the federal government's S&T strategy[25] and its government-wide planning exercise[26]—they were not meant to define or measure capacity but were meant to be somewhat provocative in order for managers to test their own current thinking.

In Phase 1 of the study dealing with the scenario description drivers, environmental, economic, industrial, social, fiscal, policy and S&T elements were reviewed. In Phase 2, research, policy advice and staffing considerations were reviewed, along with infrastructure and partnerships. Finally, implications were sketched for SBDA roles, resources, personnel, facilities and equipment, science–policy linkages, and business

Table 2. Outcome drivers

1. Research	These describe the implications of each scenario for the SBDA's research activities
2. Policy advice	These factors explore the changing demands and resources for science policy advice in each scenario
3. Staff	Staff drivers explicitly examine the implications for the different scenarios on retention, rejuvenation and recruitment of scientific, technical and policy staff
4. Infrastructure	Each scenario will demand a different type and level of R&D infrastructure. These are explored here
5. Partnerships	The value and necessity for forming external S&T partnerships changes in each scenario. Partnership considerations are described here
6. Other	This group includes a set of miscellaneous outcomes that have a bearing on science capacity

Source: John de la Mothe and Ron Freedman for The Impact Group (Toronto).

Table 3. Capacity planning implications

1. Role	These examine the role that the SBDA's S&T play in achieving the federal government's S&T objectives (wealth creation, quality of life, advancement of knowledge) as well as SBDA's broader role in Canada's national system of innovation
2. Resources	Here, the analysis examines different strategies for securing and deploying the resources needed to carry out a SBDA's mandate in each scenario
3. Personnel	Each scenario implies different personnel and skill set requirements. This analysis examines the type of skills needed and how they can be obtained
4. Facilities & equipment	Under each scenario the SBDA will have a different capability to operate and acquire the facilities and equipment it needs to fulfil its mandate. This category examines different strategies for matching requirements to available facilities and equipment
5. Science-policy linkage	SBDA's capacity to provide science support to policy development changes in each scenario. Here we explore the nature and extent of those changes
6. Business arrangements	The ways in which a SBDA lab relates to stakeholders inside and outside of government are likely to vary under each scenario. This analysis examines different implications for business arrangements with external stakeholders and other SBDAs

Source: John de la Mothe and Ron Freedman for The Impact Group (Toronto).

arrangements. As a result, a number of themes thought to be worthy of consideration were revealed.

Linkages, Networks and Alliances are Key

In the emerging Canadian context, external lab linkages, networks and alliances will be critical for the SBDAs to meet their public responsibilities. In some cases, external connections are needed to make up for gaps in in-house capacities. In some, they are prerequisite to demonstrating the needed support to request further federal funds in order to build additional facilities. In some cases, linkages are needed to ensure a flow of young research talent into the SBDAs. In other cases, they are important for cross-departmental planning and resource sharing. In the case of priority setting, each SBDA should seek to fill sectoral gaps (e.g. in the case of Natural Resources Canada, remote sensing, mining and geology are obvious targets for assessment).

Money is Not the Solution

The 'reinvestment scenario', in which the federal government would make a significant amount of money available to renew SBDA research facilities and equipment, at first blush seems like a heaven-sent opportunity. As already noted, however, and on closer inspection, it is unlikely that the government will have enough money to meet all the reinvestment needs of the SBDAs. Particularly in a time of surplus budgets, federal science is not the only mouth to feed as numerous programs and communities (many with political constituencies) feel that they have a higher level immediate claim on newly available resources. These conditions prompt the observations that each department will need to improve its science policy capacity in parallel with its research capacity.

Skills Planning Needs to be Future Oriented

It is essential that the federal labs ensure a flow of research talent into the future if capacity is to be improved. Given the pressures outlined above, it is clear that demographics (aging) and poor career prospects will make it difficult to attract high caliber researchers. This pressure is augmented by the fact that science and science-based public problems are both moving rapidly thus requiring that the SBDAs develop a human resource approach that is flexible and adaptive. One element of this response might not only mean building linkages with university departments, but also creating specialized (departmentally dedicated) 'farm teams'.

Technologies are Moving Too Fast

Research technology is moving too fast for organizations to afford to stay at the leading edge or to recoup their investment prior to technological obsolescence. For example, in the natural resource sectors, opportunities are growing quickly for applications of information and decision-making technologies as well as systems in remote sensing and GPS. This calls for developing creative partnerships with hardware, software and equipment suppliers as well as with external research groups so that edge technologies can be accessed without appropriating the full costs involved.

Cross-department Cooperation is Increasing

As noted in the December 1998 report of the Office of Auditor General,[27] cross-SBDA cooperation is beginning to yield positive benefits. This trend is being driven by both the need to address horizontal policy issues such as climate change and productivity as well as by common resource constraints. This latter condition will continue to hinder the ability of single departments to finance solutions themselves, thus suggesting that joint ownership and operation of facilities and equipment might be worthy of study.

Research or Science Assessment?

It is obvious that no government department can hope to perform more than a small fraction of all the research that is relevant to a particular issue. This simple observation is amplified when it is noted that Canada only produces about 4% of the world science and technology. Thus the vast majority of relevant research will be undertaken outside federal labs—in universities, industry, at home and abroad, and published in a vast multidisciplinary world literature. Moreover, this will often be transferred through personal networks or embodied in new technology.

Support for science policy often involves providing timely information to government decision makers about what to do on a particular issue. Given that information is often incomplete and results uncertain, scientists are often reticent to offer advice in this regard. This points to a gap in capacity that needs to be narrowed by government scientists in understanding their role *qua government* scientists, not 'Scientists'.

Conclusion

Canadian policy has, in recent years, spoken of innovation systems, reviewed its science systems, and enunciated management principles. It has reacted to a variety of science-based crises and there is a worldwide anticipation that science-based issues will only increase in frequency and importance. (BSE, Hantavirus and GM foods are but three recent examples.) Yet Canada continues to have no effective system of science priority setting or management in government. International experience suggests that establishing S&T priorities in the public interest will be increasingly essential, but to get there government needs a framework and indicators to effectively monitor its performance. This framework needs to be linked to the strategic management of its SBDAs. Without such equipment, parliamentarians and government managers will continue to have no basis for assessing government expenditures on science, monitoring the capacity of its lab system (and adjusting to needs accordingly) or setting clear priorities. This paper has outlined some pressures and possible principles for SBDAs to approach these issues. Beyond this, the SBDAs might well begin to act as a unified Science Portfolio, and not just as an adjunct of the Industry Portfolio which serves different purposes and interests. Moreover, focusing on science capacity and priority setting issues (instead of reacting against decreasing resource envelopes) may well help the SBDAs within government and position the Canadian government to better identify, anticipate and respond to public interest issues and responsibilities.

Notes and References

1. An earlier version of this paper was presented at a NATO Advanced Research Workshop on the Reform of Federal Laboratories in Manchester, England on 3–5 June 1999. In the preparation of this paper, I would like to thank Tyler Chamberlain for his research assistance.
2. Cf. B. Å. Lundvall (ed.), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter, London, 1992; Christopher Freeman, 'Japan: A new national system of innovation', in Giovanni Dosi *et al.* (eds), *Technical Change and Economic Theory*, Pinter, London, 1988; and 'The national system of innovation in historical perspective', *Cambridge Journal of Economics*, 19, 1, 1995, pp. 5–24; and Richard Nelson (ed.), *National Innovation Systems: A Comparative Study*, Oxford University Press, New York, 1993. See also Charles Edquist (ed.), *Systems of Innovation: Technologies, Institutions and Organizations*, Pinter, London, 1997; John de la Mothe and Gilles Paquet (eds), *Local and Regional Systems of Innovation*, Kluwer, Boston, 1998.
3. The language of national systems is extended in a recent book in the form of a political argument for the need of 'national projects' in order to regain a sense of leadership in government. Cf. John Godfrey and Rob McLean, *The Canada We Want: Competing Visions for the New Millennium*, Stoddart, Toronto, 1999.
4. John de la Mothe, 'Canada and national systems of innovation', *Innovation, Science and Technology Review Resource*, Volume II, Government of Canada, Ottawa, 1994, pp. 11–20.
5. These issues are dealt with in detail in John de la Mothe, 'One small step in an uncertain direction: the Science and Technology Review and Public Administration in Canada', *Canadian Public Administration*, 39, 3, Autumn 1996, pp. 403–17.
6. Cf. Chapter 15 of the September 1996 Report of the Office of the Auditor General. For a detailed discussion of the challenges of small open economies, such as Canada, in setting priorities for its science budgets, see John de la Mothe and Paul R. Dufour, 'Engineering the Canadian comparative advantage: Technology, trade and investment in a small open economy', *Technology in Society*, 12, 4, 1990, pp. 369–396.
7. Cf. Imre Lakatos and Alan Musgrave (eds), *Criticism and the Growth of Knowledge*, Cambridge University Press, Cambridge, 1970.
8. Michael Gibbons *et al.*, *The New Production of Knowledge*, Sage, Beverly Hills, 1994; Michael Gibbons, 'Governments and the new production of knowledge', in John de la Mothe (ed.), *Science, Technology and Governance*, Cassell, London, 2000 (in press).
9. Susan Strange, *The Retreat of the State*, Cambridge University Press, Cambridge, 1996.
10. John de la Mothe and Gilles Paquet (eds), *Local and Regional Systems of Innovation*, Kluwer, Boston, 1998; Zoltan Acs (ed.), *Regional Innovation and Global Change*, Cassell, London, 2000, in press.
11. John de la Mothe and Gilles Paquet, 'The dispersive revolution', *Optimum: Journal of Public Sector Management*, October 1994.
12. One broad statement on this disjuncture is John de la Mothe and Paul Dufour, 'Is science policy in the doldrums?', *Nature*, 374, 16 March 1995.
13. Government documents that feature this language include Industry Canada's *Building a More Innovative Economy* (1995) and the National Research Council's *Strategic Plan* (1996).
14. Anthony Giddens, *The Third Way: The Renewal of Social Democracy*, Polity, Cambridge, 1998.

15. Robert M. May, 'The scientific investments of nations', *Science*, 281, 3 July 1998.
16. John de la Mothe and Gilles Paquet (eds), *Evolutionary Economics and the New International Political Economy*, Pinter, London, 1996; Philip Gummett (ed.), *Globalization and Public Policy*, Edward Elgar, London, 1996.
17. John de la Mothe, 'Government science in the public interest', Science Assistant Deputy Minister's Committee, Government of Canada, Ottawa, March 1999.
18. Cf. Paul Cunningham (ed.), *Science and Technology in the United Kingdom*, Cartermill, London, 1999; and Philip Gummett, Deborah Cox, Rebecca Boden and Kate Barker, 'The changing central government of science and technology', Draft Paper, NATO ARW, Manchester, England, June 1999.
19. For example, because the mandate for Therapeutic Products Division of Health Canada was written in 1953, xenotransplantation must be treated under the category of biomedical devices.
20. Please note that the abbreviations RSA'related scientific activities' (i.e. R&D + RSA = total S&T); NRES–natural Resources Canada; ENV = Environment Canada; AGR = Agriculture Canada; F&O = Department of Fisheries and Oceans; and NDEF–national Defence.
21. Conducted by John de la Mothe and Ron Freedman as part of 'SBDA capacity studies' in late 1998 and 1999.
22. John de la Mothe, 'Government science in the public interest', *op. cit.*
23. John de la Mothe and Ron Freedman.
24. For a detailed discussion of the development of the federal lab system in Canada, see Paul Dufour and John de la Mothe (eds), *Science and Technology in Canada*, Longman, London, 1993. For a sketch of what this new governance structure might look like, see John de la Mothe and Gilles Paquet, 'Circumstantial evidence: A note on science policy in Canada', *Science and Public Policy*, 21, 4, August 1994, pp. 261–8.
25. *Science and Technology for the New Century.*
26. Canada 2005.
27. *The Federal Science and Technology Strategy: A Review of Progress*, Chapter 22.