Chapter 23

SCIENCE AND TECHNOLOGY EVALUATION PRACTICES IN THE GOVERNMENT OF CANADA

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Executive summary

The science and technology (S&T) community in the Canadian federal government is responding to the same pressures as other communities in governments around the world to produce better information for taxpayers on programme achievements. At the heart of this response are a number of organisations, including the Canadian Parliament, the Auditor General, the Treasury Board, and numerous departments and agencies, each with their own perspective on programme evaluation. Members of the evaluation community are prominent in this process, given their expertise in the performance information field. This paper focuses on the evaluation of the S&T initiatives of the Industry Portfolio – a group of 13 organisations reporting to the Industry Minister.

The Canadian federal programme evaluation system has been in place for approximately 20 years. Each organisation is responsible for evaluating its own initiatives, under policy set by the Treasury Board. In most cases, an evaluation framework is established at the start of a programme. The framework identifies performance expectations and specific, detailed requirements for ongoing performance monitoring (to serve ongoing management decision making) and for a future programme evaluation study. This includes evaluation issues, performance measures, data collection, analysis and reporting, and evaluation approaches. In the evaluation study systematic research methods are used and, typically, three main issues are examined: programme relevance, success and cost-effectiveness. The evaluation function is prominent in supporting the Canadian Government's enhanced emphasis on programme outcomes and its new approach in reporting to Parliament.

As in most fields, it has taken some time to develop a specialised capability for evaluating S&T initiatives, particularly in organisations in which S&T represents but a portion of their overall activities. The traditional approaches used for assessing S&T have expanded from a focus on peer review to include other programme evaluation and internal audit methods. The development of evaluation capacity was sustained through such supportive efforts as the 1986 Treasury Board

discussion paper that outlined, for a set of "typical" evaluation issues, the topics that could be addressed for both mission-oriented and non-mission-oriented research and development programmes. In 1993, a group of federal S&T organisations produced another document which provided a critical review of evaluation methods for assessing the socio-economic impacts of government S&T.

In practice, most S&T evaluations have primarily addressed issues of concern to programme managers, rather than central agencies. Government policy was generally taken as a given, evaluated only to the extent that certain evaluation studies of specific programmes concluded that their policy rationale remained strong. Evaluation generally has played an indirect role in shaping policy, since it is only one among many inputs to the policy process. For example, the National Research Council's Industrial Research Assistance Program was examined in 1990 as one of several programmes used as policy instruments by the government.

The questions of attribution and causality continue to be challenging ones, particularly with respect to long-term impacts. While we have found no magic solutions, many organisations are now making use of the performance framework as a means to ensure that all the critical programme elements are considered and managed, and to trace, in much the same way as the traditional logic model, the plausible "pathway" from resource utilisation through activities, outputs and clients, to the resulting immediate and long-term impacts.

In keeping with the commitment outlined in the 1996 Canadian government S&T strategy to develop evaluation and measurement mechanisms, the Industry Portfolio organisations have undertaken a joint effort to measure and evaluate their S&T activities using a common approach. A performance framework has been prepared for each of four categories that group the Portfolio S&T initiatives. The four chosen categories – Advancement of Knowledge, Innovation with Firms, Innovation Systems Support, and Management – correspond closely to the objectives in the government S&T strategy. These frameworks are currently being refined in response to senior-level input, and will be the basis for determining evaluation issues, data collection and reporting requirements, and measurement and evaluation approaches at the Portfolio level.

This initiative has been successful in attracting participation from key Portfolio member organisations with S&T activities, and in reaching agreement on a common measurement and evaluation approach. This is a significant achievement, given the number and diversity of the organisations involved, and their different evaluation capacities. Another success is the acceptance by programme managers and the Portfolio Science and Technology Management Committee, of the chosen approach and the initial draft of the four performance frameworks. However, other challenges remain.

This project is complex because of the large number of initiatives and organisations. A two-tiered approach is required, and there is little Portfolio experience to draw upon in this regard. The common Portfolio-level approach will set the stage for the second-tier approaches used for individual initiatives in each organisation. The latter will need to support the former, without conflicting with the approaches already being used in the individual Portfolio organisations.

Once the work has been completed a significant task in itself – the next hurdle will be to ensure real-life implementation, and the use of performance information for management purposes. At present, there are early, encouraging signals on this matter. Activities are being planned to strengthen the management commitment that is required to facilitate implementation. This Portfolio effort is

attracting interest from other government parties and may result in the Portfolio approach serving as a basis for broader government-wide reporting on S&T achievements.

Introduction

As in many other countries around the world, there is a heightened demand in Canada for better information on the performance of government programmes. Taxpayers have become sceptical about governments and want to know how well their elected representatives are spending the tax portions of their hard-earned revenues. Governments need better information upon which to base decisions in the allocation of scarce resources, and which clearly demonstrate their achievements.

One response to this trend is the implementation of a recently-approved planning and reporting process in the Canadian federal government. All departments will be required, starting in the Fall of 1997, to submit, annually, a Spring Business Plan and a Fall Performance Report to Parliament. These two documents will emphasize, respectively, the intended and achieved results or outcomes of government operations, as opposed to activities, outputs and resource expenditures, which, previously, were the main focus of a single Main Estimates document produced in the Spring of each year. Other jurisdictions in Canada, the provincial governments of Alberta and British Columbia for example, have also launched initiatives to focus more directly on results.

These developments have significant implications for practitioners of programme evaluation. Although they may result in unreasonable expectations and demands upon evaluators, they also mean an increasing interest in their field and a heightened demand for the type of information that they generate. In Canada, the programme evaluation function is well established in the federal government, after close to 20 years of practice. Over this period, a considerable number of evaluation projects have been conducted in the Canadian federal system, many of which have dealt with a variety of research and development and S&T initiatives. This paper concentrates on describing our S&T evaluation experience, in order to share with others what we have learned.

The following section provides a description of the main government institutions that intervene in the Canadian programme evaluation field, and the policy environment governing evaluation activities. The next section focuses, in more general terms, on some of the specific developments over the years to evaluate S&T initiatives. The final section outlines a multi-organisation performance measurement and evaluation initiative that is currently under way, along with some of the challenges being faced, and the lessons being learned.

The Canadian institutional and policy context

The institutions

As a parliamentary democracy, Canada has three levels of government: federal; provincial and territorial; and municipal. Each level interacts with citizens in different ways in specific areas of responsibility, as defined in the Canadian Constitution. At the national level, the federal government comprises three parts: an *executive* arm (the Governor General, who is our head of state, the Prime Minister, and the Cabinet); a two-chamber *legislative* branch (the House of Commons, made up of elected Members of Parliament, and the Senate whose members are appointed by the Governor General on the advice of the Prime Minister); and a *judiciary*, the most important body of which is the Supreme Court of Canada.

The principal institutions which are relevant to a discussion of programme evaluation include Parliament, the Office of the Auditor General, a small number of central agencies such as the Treasury Board, and a large number of departments and agencies, some of which are grouped together in "portfolios" under the responsibility of a minister.

Parliament is the ultimate authority in the Canadian federal system, passing legislation and reviewing and approving the initiatives and expenditure plans of all federal organisations. Much of its work is supported by a structure of *committees* made up of members of Parliament from both government and opposition, with responsibility for specific matters such as the annual spending plans, the public accounts, industry, agriculture, transport, natural resources and many others. Committees play an important role in reviewing proposed legislation and any matters of special concern to Parliamentarians before the latter examine them in either the House of Commons or the Senate.

The *Auditor General* is an agent of Parliament with responsibility for ensuring that Canadian government initiatives are implemented in conformity with the wishes of Parliament, and with due respect for economy, efficiency and effectiveness. The Office of the Auditor General carries out this role by examining selected aspects of the operations of federal departments and agencies, and reporting its findings and recommendations directly to Parliament.

The *Treasury Board* is a Cabinet committee of six government ministers, with responsibility for the overall management of the federal public service. It is supported by a *Secretariat* made up of public servants. The Treasury Board's responsibilities include setting policy on a wide range of matters such as human resources, financial management, and administration. It fulfils three roles: that of government *expenditure manager* (preparing the government's expenditure budget and monitoring programme spending in departments); that of *employer* (setting the terms and conditions of employment in the public service); and that of *general manager* (establishing the policy framework in a wide variety of areas such as accounting, audit and programme evaluation, financial management, information technology and procurement). The Treasury Board sees that the policies and programmes approved by Cabinet are translated into operational reality, and that departments have the resources and administrative environment required to do their work.

There are over 70 federal "mainstream" *departments and agencies* delivering programmes and services to Canadians in a wide range of fields (environment, agriculture, public security, industrial development, natural resources and foreign affairs). Many enabling activities, such as research and development, are performed within numerous organisations in support of their specific mandates.

Some ministers oversee a "portfolio" of organisations with mandates that, for the most part, have a degree of commonality. Of particular interest here is the Industry Portfolio, headed by the Minister of Industry, comprising 13 organisations with diverse mandates, objectives, capabilities and cultures, most including some S&T activities or support to innovation (see Table 1).

The range of responsibilities in the Industry Portfolio includes:

- ◊ providing research grants in the fields of natural and social science and engineering;
- ◊ operating science and engineering labs facilities, and a communications research institution;
- ◊ defining and enforcing market-place regulations, and promoting voluntary standards;
- ◊ supporting industrial and regional development;

- ◊ collecting, publishing and analysing national socio-economic statistics; and
- ◊ offering financial and business support programmes and services.

Table 1. The industry portfolio

A wide variety of organisations
Atlantic Canada Opportunities Agency
Business Development Bank of Canada
Canadian Space Agency
Competition Tribunal
Copyright Board of Canada
Federal Office of Regional Development (Quebec)
Industry Canada (Includes the Communications Research Centre)
National Research Council of Canada
Natural Sciences and Engineering Research Council of Canada
Social Sciences and Humanities Research Council of Canada
Standards Council of Canada
Statistics Canada
Western Economic Diversification

The government policy on programme evaluation

Federal government policy on programme evaluation is set by the Treasury Board. The first such policy dates back to 1977. It called for an evaluation capacity to be established in various federal organisations and for organisations to evaluate all their programmes on a cyclical basis.

The federal evaluation model is a decentralised one. Each organisation is responsible for evaluating its own initiatives through an internal evaluation function that is independent of line management. The results of evaluation studies must be shared with interested external parties, such as the Treasury Board, parliamentary committees, Parliament and others, including the public. In addition to setting policy, the Treasury Board contributes to the programme evaluation function by establishing standards for evaluation, providing technical advice, ensuring the availability of training and development for practitioners, monitoring the quality of the evaluation work conducted by departments and agencies, and leading centrally-requested evaluation projects.

Programme evaluation, in this setting, is typically an *ex post facto* exercise, concentrating on initiatives that have been in operation for some time, usually to find out how well they have functioned and how they might be improved. The results of such evaluations also constitute “normal” input to the shaping of policy and new programmes. In addition, those responsible for the policy function in most government organisations also undertake *ex ante* evaluation work for the explicit purposes of formulating policy. This work is often carried out in policy organisations rather than in programme evaluation units, although some of the research methods may be common to both functions.

Some of the key provisions of the current policy, which is not fundamentally different from that issued 20 years ago, are highlighted below:

◊ *Policy statement*

"It is government policy that departments evaluate their key policies and programmes strategically and cost-effectively and use the findings in decision making and reporting.[1]

◊ *Purpose of programme evaluation*

Evaluation serves to address such matters as the extent to which government initiatives have been successful, whether they can be improved, whether they should continue, and whether there are more cost-effective alternatives. This is achieved through the use of systematic research methods that provide relevant, objective, and credible evidence on the effectiveness of programmes.

Although programme evaluation has been established for close to 20 years in the federal system as a means to obtain useful information on the results of government initiatives, recent developments in the way departments and agencies report to Parliament have reinforced the relevance of the function. The new system accentuates the shift in focus from resources, activities and outputs to achievements. As previously mentioned, each department and agency will be required to submit a Spring Plan that outlines intended results for the coming year, and a Fall Performance Report that outlines achievements (six months after the end of the previous fiscal year which is the subject of the report).

◊ *Scope of programme evaluation*

The policy on evaluation calls for the function to provide information that addresses three basic programme evaluation issues: programme relevance (whether a programme continues to be consistent with organisational and government-wide priorities, and to be an appropriate response to an ongoing need); programme success (whether the initiative has met its objectives and is producing the intended outcomes); and cost-effectiveness (whether the programme incorporates the most efficient design and delivery alternatives).

◊ *Strategic view/selectivity*

Originally, it was expected that departments and agencies would evaluate all their initiatives over a five- to seven-year cycle. The current policy allows for greater selectivity in the use of increasingly scarce evaluation resources. While all programmes should be considered for evaluation, strategic choices are now encouraged, so that the evaluation activities are aligned with the priorities and needs of the department – and of the government.

◊ *Typical evaluation process*

Most departments and agencies implement the Treasury Board policy on evaluation in a manner that is consistent with their own internal needs and organisational culture. Typically, this involves conducting an *evaluation framework* and an *evaluation study*. The framework is prepared early in the life of an initiative. It is based, in many organisations, on a performance framework – a 'cousin' of the traditional logic or causal model – which sets out the initiative's performance expectations in terms of

resources, activities and outputs, reach (or the parties targeted by and involved in various initiatives), and the resulting short- to long-term outcomes.

The evaluation framework sets the stage for both ongoing monitoring – or performance measurement – and the future evaluation of the initiative. Performance data are collected as the initiative is implemented. This serves ongoing management needs and establishes a results information base which, along with data from whatever additional research is necessary, feeds the in-depth evaluation study at some time in the future. Prior to the evaluation study, the original evaluation issues are reviewed and updated and the most relevant ones are retained for investigation, along with the most appropriate and affordable research methods."

Science and technology assessment in the Canadian federal government – an overview

Introduction

This section reviews the history of S&T evaluation within the Canadian federal government and discusses its use to investigate impacts and effects of programmes and activities and the value of specific policy initiatives.

History (1982-95)

As a specialised field, assessment of S&T programmes within the federal government became prevalent in the early 1980s, about five years after evaluation was instituted as common practice. For many departments and agencies, S&T activities and programmes form a small fraction of the total, and internal evaluation groups did not have S&T evaluation specialists. In other organisations such as the Natural Sciences and Engineering Research Council, Natural Resources Canada and the National Research Council of Canada have virtually all their resources dedicated to S&T programmes. In such organisations, specialised S&T evaluation capabilities have been developed. Peer review had been common practice for assessing R&D quality in these organisations since the 1960s. Additional evaluation methodologies such as client, potential client and staff surveys began to be utilised, along with case studies and benefit-cost analysis. Evaluation capability grew as staff and contract resources were provided and experience was gained. Utilisation increased as senior management became more aware of, and confident in, the quality and validity of evaluation studies on issues of concern to them.

At the National Research Council of Canada, with its extensive scientific activity, a traditional peer review process (which had high credibility with S&T staff and management) was combined with both programme evaluation and internal audit approaches, as required by central agencies, to provide a more integrated assessment capability. Internal audit focused on management practices, operational controls and adequacy of information systems to support management. Programme evaluation examined the external linkages of the organisation to its clients, stakeholders and the government as the sponsor and funding source, focusing on client feedback, and the impacts of S&T activities. Peer review provided expert opinion on scientific quality and relevance of projects and outputs.

In its role as a co-ordinating central agency, the Treasury Board Secretariat provided support and guidance to S&T evaluation within departments, reinforcing to departments the need to link evaluation issues to government-wide S&T policy as well as departmental concerns. One example is a 1986 discussion paper[2] which provided a generic approach to evaluating R&D within the federal

government. This paper described fundamental and applied research and development in terms of mission-oriented and non-mission-oriented categories. It provided a series of evaluation topics for each in terms of the then standard evaluation issues of rationale, relevance, programme management, outcomes and alternatives. Table 2 summarises the themes presented in that paper.

Table 2. Evaluation issues

Issues	Mission-oriented R&D programmes	Non-mission oriented R&D programmes
Programme rationale	- Legitimate role for government - Base conditions still prevail - Objectives still consistent with policies and priorities - Fit with innovation process - Fit with government programmes - Mix of activities will yield substantial benefits - Clearly defined clientele	- General advancement of knowledge
Relevance	- Clients/users satisfied with results	- No specific clientele
Programme management	- Management approach will yield results and benefits - Resource allocation is adequate - Management style is appropriate - Risk is adequately appraised	- Programme designed and managed in such a way that substantial high-quality research will result
Outcomes	- Objectives in terms of costs, timeliness, and results - Broad impacts and effects - Quality adequate for purpose	- High-quality research and highly trained research scientists
Alternatives	- In-house *vs.* contracting out - Contributions *vs.* in-house or external research - Universities or industry	- Funding effect on quality of research

Utilisation

Since evaluation capability was situated within departments and agencies, studies tended to focus on issues of concern to departmental management rather than central agencies. A 1989 Treasury Board review showed that many studies focused on ways to improve programme operations and delivery, to reduce costs or make programmes more effective.[3] Information from client surveys provided managers with a broader perspective on their clients' interests and opinions than was previously available to them, and assisted them in programme redesign to better fit client needs. Studies also identified special concern by management and staff regarding the difficulties in providing, within a government bureaucracy, a positive environment and the appropriate incentives for scientific progress and technology transfer.

Policy evaluation

Because of the location of the evaluation function within departments rather than a central agency, evaluation studies usually had less direct effect on policy. In many cases, evaluation studies took the policy rationale as a given, as it was a decision of government, or provided evidence that the policy rationale for existing programmes remained strong. When policy changes did occur, evaluation studies usually constituted one of a number of influences which were considered by management.

The 1990 evaluation of the NRC's Industrial Research Assistance Program (IRAP) included a review of the strategic role played by IRAP as a S&T policy instrument.[4] IRAP is a federal technology extension programme (C$ 100 million per year) which delivers technical and financial assistance to over 6 000 small and medium-sized firms annually through a network of 250 industrial technology advisors who visit firms to discuss their needs, and assist in developing specific solutions to identified needs.

The policy analysis compared IRAP activities and approaches with specific S&T policies. Table 3 is taken from the study report and summarises the analysis and the correlation between IRAP and government S&T policies. Other parts of the IRAP study focused on the extent to which IRAP was able to achieve these objectives.

Table 3. Linkages between government science policy and IRAP design and delivery features

Policy thrusts	IRAP feature
- S&T is a means to achieve social and economic objectives	- Programme mission is to provide technical assistance to, and promote the use of technology by, Canadian firms
- Industrial innovation and the use of technology are key to economic growth	- Provides technical advice and financial assistance to improve the technical capability and competence of the firm
- Government S&T initiatives should be based on industry needs except for government missions	- Responds to the needs of the individual firm, particularly small and medium-sized enterprises
- Focus on strategic technologies important to Canada	- Technical advisors include technical specialists who deliver advice and assistance in strategic and technology-intensive areas (*i.e.* biotechnology, software)
- Encourage collaboration effort among and between public and private sectors to improve diffusion and create a critical mass	- Network interactions and IRAP-R* design encourage collaboration between university and government laboratories and firms in developing technology and innovation ** a component of IRAP*
- Commercialisation and transfer of technology developed in university and government laboratories to private firms	- IRAP-R objectives include the commercialisation and transfer of technology from university and government laboratories to private firms. Scientific advisors assist in this process
- Supply and training of highly qualified human resources	- Provides linkages between firms and technically skilled personnel, and encourages the use of S&T personnel by the firm through financial assistance for the life of the project - Delivers professional development and work experience to over 2 000 university students annually
- Public awareness of value of S&T to Canada	- Promotes and demonstrates value of S&T directly to Canadian industrial firms, and to industrial associations and government agencies through the technology network and provision of technical assessment services

The study also analysed IRAP as one of the wide range of programmes used as policy instruments by the government. These included research and development tax credits, industry sector financial assistance, strategic research support, funding of university and government laboratories to perform research and development, etc. Of all these instruments, IRAP was found to be the most flexible and decentralised, and to be virtually unique, having little or no overlap with other government programmes.

Evaluation has become a more generally accepted management tool, not only to demonstrate the value of past decisions, but also to assist in ongoing operational and strategic decision making. An example of the commitment to evaluation as a basis for S&T policy review can be found in the 1996 Industry Portfolio response to the Canadian Government report *Science and Technology for the New Century: A Federal Strategy*. The response contains a commitment to assess the effectiveness of specific government S&T policy initiatives in spurring innovation, providing a direct link to the relative performance of various government policies.[5]

Impacts and effects of S&T

One of the primary uses of evaluation has always been to examine the results of S&T activities and programmes. While attribution and causality are always problems in studying programme impacts, they are even more problematic for many S&T programmes, especially with respect to long-term impacts. As stated in one study;

> "Research is usually one of the first steps on a long road to an ultimate result, be it commercial success or acceptance of a new analytical technique, consequently attribution of benefits among the various inputs is uncertain. The term "necessary, but not sufficient" is perhaps useful here. Rather than attributing various percentages of a firm's new sales to R&D, marketing, financing, etc.; in reality each is often essential to ultimate success."[6]

A 1993 review of S&T impact analysis was sponsored by eleven federal S&T departments and agencies performing S&T activities. It analysed Canadian and international published and "grey" literature and current practices within major S&T departments. The resulting report entitled *Methods for Assessing the Socio-economic Impact of Government S&T*[7] provides a critical review of appropriate methodologies for assessing the impact of various types of S&T activities. Appendix A provides a summary of the applicability and characteristics of the major methodological approaches appropriate for S&T impact analysis. Most of the methods are well known. *Modified peer review* includes experts with background in fields other that S&T, such as economics or business, or clients and users from the field for which the research is being carried out. *Partial indicators* involves selecting a small number of indicators representing inputs, activities, clients and impacts. *Integrated partial indicators* extends the use of indicators and involves preselecting and weighing a number of quantitative and qualitative indicators which, together, form an overall score for the S&T activity being evaluated.

During this review it was concluded that practical methods are available for assessing the impacts of the majority of S&T activities. It was noted in the report that, while precise answers are not always possible, it is both feasible and useful to incorporate socio-economic impact assessment as one element of the management of government S&T programmes and activities.

There are a number of approaches which can be followed to deal with attribution and causality. At one extreme, the immediate results that are directly attributable to the research are measured, with relatively little attention being paid to demonstrating the connection between the immediate results and longer-term impacts. At the other extreme, longer-term economic impacts (jobs, sales and other economic impacts) are measured, claiming or inferring a high degree of attribution to the S&T (which may not be true). There is often pressure to lean toward this second approach from programme managers intent on demonstrating substantial impacts to those providing the programme funding.

In recent years, there has been increased use and acceptance of a more balanced approach which makes use of a "performance framework". This provides a more credible results statement, more useful information for operational and strategic programme management and accountability purposes. The performance framework builds on the traditional logic diagram by adding a "reach" element for specific consideration of clients and recipients, through which impacts are achieved. In this manner, the approach provides a description of the intended causal relationship between the use of resources to perform activities and create outputs, which are then transferred to the target clients with the resulting immediate, intermediate and long-term impacts related to the S&T. The intended "pathway" between policy decisions, the application of S&T funding and the intended long-term impacts can be monitored by the use of indicators of performance.

The performance framework approach has brought increased attention to developing and measuring intermediate indicators of performance factors, such as client profile characteristics and immediate impacts resulting from the interaction. End-of-project client feedback forms are used at the National Research Council, both in the laboratory and in the Industrial Research Assistance Program to gather basic service quality and immediate impact data from clients on an ongoing basis. Programme managers use this information to monitor programme delivery and also to support periodic review. One of the problems with traditional periodic evaluation has been the lack of available background information on the nature of the interaction to support the review. The ongoing collection of intermediate performance data helps to fill that gap. A more detailed example of the application of this approach is provided in the following section.

The case of the Industry Portfolio Science and Technology Initiatives

Context

In 1994, recognising the importance of S&T in the development of modern economies, the Canadian government undertook a major review of its direct investments in this vital field (approximately C$ 5 billion in 1995-96.[8] Consultations in communities across Canada, five regional conferences and a national forum involved over 3 000 Canadians in the process. The results, along with input from federal departments and agencies, set the stage for a new approach to S&T in Canada as it prepares for the emerging knowledge-based and innovation-based economy of the 21st century.

The federal government policy arising from the S&T review was released in March 1996. This document, entitled *Science and Technology for the New Century – A Federal Strategy:*

- ◊ defines national goals;
- ◊ describes the federal government's core S&T activities;
- ◊ outlines a new governance system based on mechanisms for receiving expert advice, improved interdepartmental co-ordination and more effective management; and

- ◊ introduces operating principles to guide departments and agencies in performing and investing in S&T.[9]

As part of this federal strategy, the Minister of Industry released a document outlining the contribution of the Industry Portfolio to the broader government effort.[10] Together, the Industry Portfolio organisations involved in S&T activities account for the largest portion of direct federal S&T spending under a single minister (42 per cent, amounting to more than C$ 2 billion.

The Industry Portfolio Science and Technology Action Plan set out a common vision and shared goals for the Portfolio organisations. This set the stage for closer co-operation, stronger partnerships and increased synergies among government organisations, in order to better fulfill the government's role as a catalyst within Canada's innovation system, in spite of declining resources. A wide variety of specific initiatives – approximately 50 in all – are outlined in the Action Plan, as are a set of operating principles dealing with increased effectiveness, partnerships, prevention and sustainable development, competitiveness with respect to the regulatory framework, information networks, international linkages and science culture.

The Action Plan identifies the need for a Management Framework, briefly outlining the intent to establish new governance and co-ordination mechanisms. It also includes a commitment to developing an evaluation framework and measurement mechanisms to assess the effectiveness of individual and joint initiatives:

> "The goal is not only to establish clear targets and objectives, but also to shed light on key issues. These include the process of innovation; the adoption of innovation and resulting technologies by Canadian firms; the contribution of innovation to private-sector competitiveness, export performance and job creation; and the effectiveness of government S&T policy initiatives in spurring innovation."[11]

The remainder of this section provides a summary of recent efforts to establish a common results-based performance framework for the S&T initiatives of the various organisations within the Industry Portfolio.

Organisational framework

The management of horizontal policy and programme issues which span the Industry Portfolio is overseen by a Committee comprised of the deputy heads of all Portfolio organisations. While S&T represents only one of the many matters of interest to this group, it is the prime responsibility of the Science and Technology Management Committee for the Industry Portfolio (S&T MCIP). This Committee is headed by a Vice President of the National Research Council of Canada, and includes senior-level representation from all Portfolio member organisations. The S&T MCIP called for the establishment of a Sub-Committee that would concentrate on developing the approaches required for the Portfolio to focus on ways of measuring and reporting its S&T achievements. Membership on the Sub-committee on Evaluation and Performance includes programme evaluation practitioners from across the Portfolio. Specifically, the Sub-Committee's terms of reference included the following:

- ◊ review current practices within the Portfolio for the collection, analysis and reporting of performance;
- ◊ determine and share current best practices for assessing and reporting on performance;

- ◊ develop a Portfolio approach to performance measurement, programme evaluation and reporting, including both individual organisation and Portfolio initiatives; and
- ◊ co-ordinate and facilitate communication and interaction among Portfolio members in order to develop improved capability to determine and report on performance.

Early challenges

The Sub-Committee was successful in attracting representatives from the key Portfolio S&T organisations. Given the scarcity of collaborative programme evaluation work on an extensive scale in the past and the already considerable workloads in each member organisation, this is a sign of the importance that is attributed to this work.

The potential difficulties in agreeing upon a common measurement and evaluation approach did not materialise. Sub-Committee members were quick to agree on the value of an approach that several organisations, both within the Portfolio and elsewhere in the federal government, had either contributed to developing or had already used. This approach is described in the next section.

There is considerable diversity among the members at the Sub-Committee table. All member organisations within the Industry Portfolio are represented. The extent of their programme evaluation capacity and experience varies significantly, and they come from environments with differing management styles and organisational cultures. The fields of activity to which they apply evaluation methods in their own organisations vary widely. Some are primarily research and development performers, and others, such as Statistics Canada, perform mostly Related Scientific Activities (RSA) as defined by the OECD's *Frascati Manual*.

This level of diversity could potentially cause some difficulties, although to date it has not. In fact, it may prove to be a source of strength for the Sub-Committee, providing the group, overall, with a better understanding of how to approach the different fields of activity at hand.

One area in which the Sub-Committee has limited experience, and in which it feels that it will be breaking new ground, is in the development of two-tiered measurement and evaluation approaches. The first tier is the broad Portfolio level, which transcends the member organisations. The second tier is at the level of the 50 or so specific initiatives, based in the different organisations. The challenge will be not so much to define the top-level approaches, as to develop initiative-level approaches that can support those at the Portfolio level, while not conflicting with the individual evaluation approaches used in each member organisation. Developing a performance framework is the first step.

The performance framework approach

Like all government organisations, the Industry Portfolio needs to develop a compelling story about its achievements so as to demonstrate the value it is adding to the government's S&T and other efforts. This is what the Canadian public has been demanding with increasing insistence, as it seeks reassurance that it is receiving value from government. However, it is not sufficient to tell the story in terms of the amounts of resources consumed, nor in terms of the activities completed and outputs produced. Reporting must be more balanced. The performance framework helps achieve better balance by ensuring a focus on reach (or the parties targeted by and involved in various initiatives)

and on the results or outcomes achieved. While the initial thrust is on performance reporting, it is expected that increased emphasis on managing S&T to improve overall performance will follow.

The performance framework is based on three key, interrelated elements which underpin typical government operations. They identify what we are doing (in other words, how we intend to achieve intended outcomes), to, for, with whom, and why. These elements have come to be known in the evaluation community as "The Three Rs":[12]

- ◊ *Resources:* These are financial and human resources and materials used to produce or "purchase" various activities, outputs, services, products, etc., or the "what we are doing" elements. They provide a clear indication of **HOW** we intend to produce certain results. Traditionally, of the three elements, this is the one with which government managers are most comfortable, and which they have measured and reported most successfully. Evidence of this lies in the typical departmental plans and reports of past years, which were more activities- than results-based, and in the magnitude of the systems available for tracking and reporting resource consumption.
- ◊ *Reach:* This can include a variety of parties, which, depending on the nature of the initiative, may be clients, beneficiaries, recipients, stakeholders, partners, intermediaries, co-delivery agents, etc. This is the **WHO** element of an initiative – an important one, since success is achieved only to the extent that we interact with the appropriate parties to reach the intended constituencies that an initiative is intended to influence or serve.
- ◊ *Results:* These are the expected outcomes of initiatives, often called results, impacts and effects, ranging from direct or immediate impacts to ultimate or long-term outcomes. These are usually the consequences – a new state of affairs or a change in behaviour – that can be plausibly attributed to the initiative. They are usually the elements that explain **WHY** an initiative has been undertaken.

Table 4. Elements of the performance framework

HOW? (RESOURCES)			WHO? (REACH)	WHY? (RESULTS)	
Inputs	Activities	Outputs		Direct/short-term results/outcomes	Long-term results/outcomes
Financial Human Material etc.	Various things we do	Various things we produce	Parties that: - we interact with; - we seek to influence; - deliver our initiative. Stakeholders	- Changes in behaviour - Level of satisfaction	Broader, longer-term scientific, economic or societal impacts

These three elements constitute key performance areas of a typical operation, which managers must examine regularly. The direct relationship between the three elements make this a powerful model for constructing a balanced performance story, and for making management trade-off decisions. Changing the level of one of the three entails an adjustment in one or both of the others. For example, a resource reduction means fewer activities/outputs, resulting in a narrower reach and (or) fewer (or more "superficial") results. A manager who uses information to manage all three elements will have a well-balanced view of his or her operation. Table 4 on the following page brings together the elements of the performance framework as well as the spectrum of questions it helps to address.

The performance framework is not only a valuable accountability or reporting tool. In fact, the use of the framework in this manner almost dictates that it also be used for strategic planning and operational management purposes. Its strength here lies in its ability to ensure that initiatives are designed with a clear emphasis on intended results. It can serve as a starting point in the formulation of annual operational work plans, and to provide a basis for a common vision – including specific operational targets – among the parties delivering the initiative. From an evaluator's perspective, it serves for establishing performance measures, identifying programme evaluation issues, establishing an ongoing monitoring and reporting strategy, and developing an approach to programme evaluation.

The performance framework in the Industry Portfolio

In order to make the use of the performance framework manageable, it was necessary to categorise the 50 or so initiatives into logical, manageable groupings. Any categorisation of S&T initiatives must take account of the complex variety of activities and outputs, users/beneficiaries and results in order to credibly demonstrate performance against policy objectives. On the one hand, a traditional focus on the nature of activities (*e.g.* basic research, applied research, development, related science activities) does not allow one to focus on the purpose of the work. On the other hand, a categorisation by intended outcomes (*e.g.* direct wealth creation *vs.* public good) does not readily allow for the indirect benefits which so often result from innovation initiatives. For example, environmental protection research leads to policy initiatives and development of standards to protect the environment – a public good, but also provides new market opportunities in testing equipment and other products for private enterprise – wealth creation.

The objective for the Industry Portfolio is to develop and implement a method of understanding and measuring S&T performance in terms of government objectives which recognises the nature and purpose of portfolio S&T initiatives and is understandable and practical as well as incorporating current best practices and theory. The approach which has been developed meets these objectives. The categories chosen identify strategies for attaining the four government goals for S&T, in terms of the nature of activities and outputs, the reach or key users, and the outcomes and impacts of the work.

Table 5 presents the four categories used within the Industry Portfolio in terms of the corresponding objectives of the government S&T strategy:

Table 5. Industry Portfolio categories

Government strategy	Evaluation categories
To provide excellence in scientific discovery and advancement of knowledge	1. Advancement of Knowledge
To ensure the application and commercialisation of S&T to create jobs and economic growth	2. Innovation with Firms
To apply S&T to improve the quality of life and social well-being of Canadians	3. Innovation System Support
To develop and apply new mechanisms for the governance and management of S&T	4. Management

These four groupings are consistent with other approaches to science policy categorisation that have evolved over the last two decades.[13] Along with the performance framework, establishing these categories will facilitate the task of telling a balanced and compelling performance story for the

Industry Portfolio S&T initiatives. They will allow the Portfolio to measure and understand the performance of its S&T initiatives in terms of their nature and purpose as well as in terms of outcomes. Table 6 provides a high-level overview of all four categories.

Broadly speaking, the *Advancement of Knowledge* category captures those activities designed to build and maintain Canadian S&T capability to meet the application needs inherent in the next two categories. *Innovation with Firms* focuses on government support for individual firms through collaborations, technical and financial support and similar activities, and the economic benefits resulting from those private benefits (jobs, sales, etc.). The third category, *Innovation Systems Support*, is intended to capture the wide range of benefits created by government and which accrue to many or all citizens and firms collectively. These are normally considered "public good benefits". Activities such as regulation and standards, S&T information, policy decision making and implementation which are supported by S&T fall into this category. The final category is *Management.* While not totally ignored, S&T management has often been considered overhead, almost unnecessary. In fact, strategic and operational management of S&T resources is crucial to ensuring the relevance of activities and competencies to organisational and national requirements. The introduction and use of the performance framework approach can in fact be considered an activity under S&T management.

Table 6. Summary S&T performance framework

HOW?	WHO?	WHY?	
Resources	Reach	Results	
Inputs, activities, outputs	Clients/users/ co-deliverers/ beneficiaries	Direct outcomes	Ultimate impacts
Advancement of Knowledge Strategic & fundamental research	Scientific/academic community. Universities, government laboratories.	Development of new knowledge in strategic areas.	Strong research base in universities and government laboratories.
Innovation with Firms Economic growth applied R&D, innovation, technology transfer & commercialisation support	Firms, associations.	Enhanced innovative capability. New, improved products, processes, services.	Increased competitiveness. Effective positioning of Canadian firms and research in the world.
Innovation Systems Support Government, policy, regulation, S&T data	Public, private sector, policy makers, regulators, and advisors.	Use of S&T indicators in industry, government policy and decision making. Supportive S&T infrastructure. Market-place confidence.	Improved public security, safety, and well-being. Effective and recognised system of innovation.
Management Co-ordination, entrepreneurial practices	Portfolio management. Linkages with partners.	Effective leadership, and performance management. Improved service/ programme co-ordination and delivery.	Maximise efficiency and effectiveness. More entrepreneurial government organisations.

A more complete and detailed performance framework for each category is presented in Appendix B. These four performance frameworks provide a summary description of each grouping and constitute a blueprint for the next steps in the work of the Sub-Committee. Next steps include the development of performance plans, measures, and results commitments for specific programmes or initiatives. The intent is for this framework to serve as a generic approach to stimulate analysis and understanding of the role and appropriate performance objectives of the various Portfolio Science and Technology Action Plan initiatives, as well as the overall S&T activities within each Portfolio organisation.. Guidelines for performance measures, information collection methods, analysis and reporting will be developed to enable the performance of specific initiatives to be portrayed and managed within a consistent framework.

Once the four performance frameworks were drafted, the Sub-Committee organised a one-day workshop for over 40 senior-level managers associated with the Action Plan initiatives. The primary purpose was to seek views on the chosen approach and the four performance frameworks, and to solicit any ideas that would help improve their accuracy. A secondary purpose was to start developing, among the programme managers, a sense of ownership of the performance frameworks, in order to encourage their utilisation. A sense of ownership at this level is considered a necessary condition to ensure that the performance frameworks become a real management tool rather than simply a conceptual document or a tool belonging to the evaluation specialists.

At this point in time, a number of challenges still face the Sub-Committee. Performance frameworks have to be refined and completed. As noted above, performance measures have to be identified, as well as data requirements, data collection methods, and approaches to analysis and reporting. In addition, evaluation issues and methods need to be identified.

The challenges ahead

Evaluation frameworks for government initiatives are not always implemented. For a variety of reasons, programme managers are often more absorbed by the ongoing challenges of delivering their programme or service. Consequently, implementing an evaluation framework somehow does not make it to the top of their priority list. To be fair, this is probably less and less true, as demands for performance information become more and more insistent. The Evaluation and Performance Sub-Committee is optimistic about the prospects for the implementation of its work; but is also realistic, recognising that there will be many hurdles to overcome.

This is not just an evaluation framework for one programme in one organisation. The presence of close to 50 initiatives spread across eleven different organisations contributing to the Industry Portfolio S&T effort make the development and implementation of this approach very challenging.

There is still a significant amount of work required to complete the four Portfolio-level performance frameworks. This work is primarily of a conceptual nature, to ensure that reliable and practical measurement and evaluation approaches are developed. These Portfolio-level approaches will set the stage for similar work at the initiative level – where some evaluation frameworks have already been developed. One challenge, here, will be achieving “coverage” of at least a majority of the key initiatives. Another will be to ensure that the approaches at each level are compatible with and complement one another. This will be a significant undertaking when one considers the large number of organisations, the differing organisational cultures, and the existing approaches to performance measurement and evaluation.

Once completed on paper, these Portfolio and initiative frameworks will have to undergo a "reality check" by programme managers who will implement and use them. Part of this exercise will include convincing managers that the potential benefits from using performance information for management purposes will outweigh the costs of the associated implementation efforts. One method that will likely be used in this process will be to conduct another S&T managers' workshop for all federal S&T organisations in which participants would review the approaches developed to ensure they are comfortable with them and, hopefully, are willing to commit to their implementation. Here, as with the first workshop, part of the intent will be to transfer "ownership" of the measurement and evaluation approaches to the programme managers.

One key factor in obtaining and sustaining management commitment to the performance framework approach will be the ability of the methods used to generate useful and timely information. This will likely involve a learning curve for managers as well as measurement and evaluation practitioners. The former will need to develop an understanding of how performance information can serve in the decision-making process to support programme management, and of how the performance information that is available can be improved through refinements, deletions and additions. Evaluation practitioners will also face new challenges. They will need to continue to build capacity in the design and use of performance frameworks, to develop an understanding of the key performance issues facing managers, and to find ways of improving not only the performance information itself, but the manner in which it is communicated to users – in short, to be responsive to managers' needs.

Experience to date shows that one does not achieve performance information perfection from the start. Rather, it is a continuous process that requires time and a certain amount of trial and error. It will be critical in the complex Industry Portfolio environment to begin with a credible first effort that does not end up being a test of managers' patience. Success in devising and implementing a measurement and evaluation approach at the Portfolio level would be valuable in extending the model to the broader government-wide S&T level of which the Portfolio is a sub-set. Ultimately, there is a requirement for the federal government to report on the achievements of all its S&T initiatives combined.

Conclusion

Government S&T initiatives constitute a complex field, and an important one from an evaluation perspective, not only because of the magnitude of the investments involved, but also because of the potential impacts of these initiatives on the social and economic well-being of Canadians. Evaluation has an important role to play by shedding some light on what works well and what does not, so that the required adjustments can be made in order to reap the potential benefits from S&T. Unfortunately, there are no "cookie-cutter" approaches available. This means that efforts are continually being directed at developing ways to monitor programme performance and evaluate achievements more effectively, with the intent of generating credible and useful information for use in management decision making, and responding effectively to the increasing demands for better information on the achievements of government S&T initiatives. This paper has outlined the current state of the art with respect to S&T evaluation practices within the Canadian federal government.

NOTES AND REFERENCES

1. *Treasury Board Manual, General Management Component; Review, Internal Audit and Evaluation,* Chapter 3-1, Evaluation Policy, Treasury Board of Canada, July 1994.

2. *Evaluation of Research and Development Programs,* Treasury Board Secretariat Guidelines, 1986.

3. Review of S&T Evaluations in the Federal Government, Treasury Board Report, 1989.

4. IRAP Evaluation Study – Final Report, National Research Council of Canada, internal report, 1990.

5. *Industry Portfolio's Action Plan – Science and Technology for the New Century,* Minister of Supply and Services Canada, March 1996.

6. *Division of Biological Sciences Program Evaluation Study Report,* National Research Council of Canada, internal report, 1988, p. 12.

7. *Methods for Assessing the Socio-economic Impacts of Government S&T,* Working Group on S&T Financial Management and Mechanisms, 1993.

8. In addition, considerable indirect S&T assistance is provided to the private sector through the Scientific Research and Experimental Development Tax credit: over C$ 1 billion in 1992. (See *Science and Technology for the New Century – A Federal Strategy,* Minister of Supply and Services Canada, March 1996, p. 8.)

9. *Science and Technology for the New Century – Summary, p. 1,* Minister of Supply and Services Canada, March 1996.

10. *Industry Portfolio's Action Plan – Science and Technology for the New Century,* Minister of Supply and Services Canada, March 1996.

11. Industry Portfolio's Action Plan, *p. 26.*

12. See Steve Montague, *The Three Rs of Performance-Based Management,* Focus, Vol. 3, Issue 6, December 1994 – January 1995. The three Rs are proposed as a basis for reporting performance, but also provide a useful "model" for planning.

13. These are described in a short paper on the rationale for the selection of the four categories: *Rationale for S&T Performance Measurement Approach and Selection of Categories,* Industry Portfolio working paper, April 1997.

Appendix A

APPLICABILITY AND CHARACTERISTICS OF DIFFERENT EVALUATION METHODS

Methods	R&D time frame	R&D type	R&D purpose	Strengths and weakness	Relative cost
Modified Peer Review	Past, ongoing and future	Basic/strategic research, Applied research, Product/process development	R&D infrastructure, policy development, policy attainment, industrial innovation (although least well suited for R&D infrastructure)	**Strengths** Ø Relatively easy to organise Ø Can provide valuable information on potential impacts Ø Probably the best method for basic/strategic R&D **Weaknesses** Ø Relies on the opinions of a small number of people Ø Qualitative information only	Low/medium
User Surveys	Past and ongoing	Applied research and development	Policy development, policy attainment, industrial innovation	**Strengths** Overcomes the problem of a small number of respondents Possible to develop quantitative indices **Weaknesses** Structuring the survey and analysing the results can be tricky	Medium (often requires considerable time to identify users, develop survey methodology, and analyse results)
Benefit-Cost Methods	Past (can be used for ongoing and future R&D in certain circumstances)	Applied research and development	Industrial Innovation (can be used for policy development and policy attainment and R&D in certain circumstances)	**Strengths** Ø Can provide reasonable and defensible estimates of potential benefits Ø Provides a structured framework for assessing R&D projects which forces the right questions to be asked **Weaknesses** Ø Can be very time-consuming and labour-intensive Ø Results are critically dependent on assumptions which can be highly uncertain Ø Because of cost and time requirements can only be used for a limited number of projects	High (data collection requirements are very demanding)

Methods	R&D time frame	R&D type	R&D purpose	Strengths and weakness	Relative cost
Case Studies	Past	Applied research and development	Policy development, policy attainment, industrial innovation	**Strengths** Ø Can provide good illustrations of the relationship between R&D and its impacts Ø Probably the best method, in general, for policy development R&D **Weaknesses** Ø Generally there is no way to "add up" the results of a group of case studies to obtain a measure of the total impacts of the group Ø The results cannot be extrapolated to other R&D projects which are not in the group	Medium (depending on the number of case studies)
Partial Indicators	Past and ongoing (and future to a limited extent)	Basic/strategic research, applied R&D, product/process development	R&D infrastructure, policy development, policy attainment, industrial innovation	**Strengths** Ø The information required to specify the indicators is relatively easy to collect Ø Probably the best method for on-going monitoring **Weaknesses** Ø The individual indicators can generally only be "added up" on a judgemental basis, making overall impact assessment more difficult Ø Provides only a very partial picture of impacts	Low
Integrated Partial Indicators	Future	Applied research and development	Policy development, policy attainment, industrial innovation	**Strengths** Ø An easy but structured way to identify research priorities Ø Forces the decision-makers to explicitly consider the key determinants of impacts **Weaknesses** Ø Totally relies on the judgement of (usually a few) individuals Ø Potential for bias in assigning weights to different criteria	Low

Appendix B

PERFORMANCE FRAMEWORKS FOR THE FOUR S&T CATEGORIES OF THE INDUSTRY PORTFOLIO

1. **Advancement of Knowledge**
2. **Innovation with Firms**
3. **Innovation Systems Support**
4. **Management**

1. Advancement of Knowledge

Definition: Advancement of knowledge initiatives relate to Canada's need to contribute to the world knowledge pool, scientific expertise, and core competencies, attracting collaborators and partners in order to influence networks and international projects, increase the awareness of new technologies and applications which will lead to international recognition, a focus on technologies critical to Canada, and better access and opportunities in frontier fields of research for public and private Canadian institutions.

HOW? Activities/outputs	WHO? Users/clients/co-deliverers/ beneficiaries	WHY? Direct outcomes	WHY? Ultimate impacts
Strategic research Development of core competencies Research facilities Research findings National/international collaborations (Networks of Centres of Excellence)	*Primary target (main direct users)* Ø Canadian scientists/academics *Collaborators/intermediaries* Ø Universities Ø International and national agencies Ø Research organisations Ø Industry (related sectors) Ø Federal funding agencies	Contribution to knowledge pool and expertise Identification of needs & Canadian research role New core competencies in priority areas Increased human resources devoted to priority areas Influence in networks & international projects Increased awareness of new technologies & applications Ability to attract collaborators/partners to Canadian enterprise	National and international recognition of Canadian research excellence and relevance Focusing of Canadian research activities on technologies critical to Canada Canadian access & opportunities in frontier fields of research Strong research base for innovation in universities and government laboratories

Note: The bold statements in the Ultimate Impacts column of these tables are from the *Industry Portfolio S&T Action Plan*

2. Innovation with Firms

Definition: Innovation with firms initiatives are intended to directly promote innovation in Canadian firms – defined as *"the successful commercialisation of an invention that enables firms to produce new goods or services, to improve on existing ones, or to improve the way existing or new products are produced or distributed.*"

HOW? Activities/outputs	WHO? Users/clients/co-deliverers/ beneficiaries	WHY? Direct outcomes	WHY? Ultimate impacts
Assistance to firms (technical and financial) Collaborative research Professional & laboratory services Facilities Technology transfer Applications of technology Incubation services	*Primary target (main direct users)* Ø Canadian industrial firms *Collaborators/intermediaries* Ø Industry associations Ø Provinces, municipalities Ø Other government departments Ø Service providers Ø Universities Ø Research organisations Ø Consortia	Use of R&D results by industry Enhanced technological expertise of industry New or improved processes, products or services used by industry Informed client decision making Enhanced innovative capacity in firms	Improved quality, safety and reliability of Canadian products, processes or services (linkage to government S&T priorities and goals) Contribution to Canadian wealth creation Increased R&D capability in industry Increased competitiveness of Canadian industry Ø Improved productivity and efficiency of Canadian industry (cost reductions, increased sales & market share, improved profits & investments) Ø Increased exports, international market share **Effective positioning of Canadian firms and research in the world**

3. Innovation Systems Support

Definition: Innovation systems support initiatives should develop and enhance linkages between the various players in the innovation system and promote the diffusion and exchange of knowledge and innovation support tools across the system and its economic clusters. Canada's efforts in supporting the innovation system include regional and community initiatives, measurement and codes, and advice to the government on science and technology matters.

HOW? **Activities/outputs**	**WHO?** **Users/clients/co-deliverers/ beneficiaries**	**WHY?** **Direct outcomes**	**Ultimate impacts**
Networking with key stakeholders in the innovation system Technical support to innovation, trade & regulatory systems National & international strategies Scientific & technical information (STI) provision Regional & community initiatives Support to government policy and national priorities Provision of S&T advice to government Codes/guidelines development Measurement standards Product certifications, quality assurance Linkages with key knowledge producers including international organisations Training/awareness	*Primary target (main direct users)* Ø Canadian private, not-for-profit, and public sectors *Collaborators/intermediaries* Ø Universities Ø Research organisations Ø Public agencies Ø Standards bodies Ø Associations Ø Municipalities Ø Provinces Ø Service sector	Use of STI by Canadian industry and government Linkages with business and finance communities Linkages of technology suppliers with users Harmonization of measurement standards Input into national trade strategies Awareness of Canadian institutional expertise & role Influence in national, international decision making Reduced barriers to trade and innovation Awareness by Canadians of innovation, technology Regional approach to innovation (clustering)	Increased awareness of S&T by industry and public Contribution to Canadian technology infrastructure **Effective and ecognised national system of innovation (integrated approach to Canadian innovation)** Advancement of technology in the market-place Improved public security, safety and well-being of Canadians Increased role for Canadian S&T community in strategic advice to government National and international recognition of Canadian S&T capability **Effective positioning of Canadian firms and research in the world** **Regions and communities linked to Canada's system of innovation**

4. Management

Definition: Management initiatives relate to activities devoted to better managing S&T work, including planning, participation, co-ordination, client service, entrepreneurship, information management, measurement, and the use of other management tools to improve the performance of S&T projects and programmes.

HOW? Activities/outputs	WHO? Users/clients/co-deliverers/ beneficiaries	WHY? Direct outcomes	WHY? Ultimate impacts
Portfolio co-ordination Strategic planning Human-resource development and management Customer focus and satisfaction Process management – policies, procedures and support systems aligned to vision Information management Management tools Entrepreneurship programmes Performance management	*Primary target (main direct users)* Ø Portfolio management *Collaborators* Ø Central agencies Ø Parliament Ø Minister Ø Service sector Ø Science-based departments and agencies	Clear direction, leadership, executive teamwork Management of information and data Understanding the business aspects of the innovation process Flexible, supportive management environment Understanding client needs and evaluating programme performance Provision of quality advice to clients Support systems aligned to the action plan Innovative management practices Co-ordinated actions among Portfolio members	Optimise technology transfer/innovation (effective/efficient) Maximise value to stakeholders Entrepreneurship culture: Ø calculated risk-taking Ø valuing clients Ø concern for employees Ø team-oriented Client-focused organisation World-class organisation **More entrepreneurial government organisations**