INVESTING IN EXCELLENCE, 1996–2001

A Report on Federal Science and Technology — 2001

Government of Canada Gouvernement du Canada

Canada

INVESTING IN EXCELLENCE, 1996–2001

A Report on Federal Science and Technology — 2001

This publication is available upon request in accessible formats.
Contact the Information Distribution Centre at the numbers listed below.

For additional copies of this publication, please contact:

Information Distribution Centre
Communications and Marketing Branch
Industry Canada
Room 268D, West Tower
235 Queen Street
Ottawa ON K1A 0H5

Tel.: (613) 947-7466
Fax: (613) 954-6436
E-mail: **publications@ic.gc.ca**

This publication is also available electronically on the World Wide Web at the following address: **http://innovation.gc.ca/s-tinfo**

Please forward questions or comments about this report to:
strategies-tstrategy@ic.gc.ca S&T Strategy Directorate, Industry Canada.

Cat. No. C2-425/2001
ISBN 0-662-66427-2
53645B

10% recycled material

CONTENTS

List of Figures and Tables

The following acronyms and abbreviations are used throughout this report:

AAFC	Agriculture and Agri-Food Canada
ACST	Advisory Council on Science and Technology
AECL	Atomic Energy of Canada Limited
CCRA	Canada Customs and Revenue Agency
CFI	Canada Foundation for Innovation
CFIA	Canadian Food Inspection Agency
CIDA	Canadian International Development Agency
CIHR	Canadian Institutes of Health Research
CRC	Communications Research Centre Canada
CSA	Canadian Space Agency
CSTA	Council of Science and Technology Advisors
DFAIT	Department of Foreign Affairs and International Trade
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
EC	Environment Canada
HRDC	Human Resources Development Canada
INAC	Indian and Northern Affairs Canada
IRAP	Industrial Research Assistance Program
NCE	Networks of Centres of Excellence
NRC	National Research Council Canada
NRCan	Natural Resources Canada
NSERC	Natural Sciences and Engineering Research Council
OECD	Organisation for Economic Co-operation and Development
SSHRC	Social Sciences and Humanities Research Council of Canada
TBS	Treasury Board of Canada Secretariat

Several abbreviations also appear throughout the text:

5NR MOU	Memorandum of Understanding on S&T for Sustainable Development
CCEU	Cabinet Committee for the Economic Union
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
IP	Intellectual property
KBE	Knowledge-based economy
MOU	Memorandum of understanding
R&D	Research and development
RSA's	Related Scientific Activities
S&T	Science and technology
SABs	Science Advisory Bodies
SBDAs	Science-based departments and agencies
SMEs	Small and medium-sized enterprises

Investing in Excellence is the theme of the 2001 Report on Federal Science and Technology (S&T) and the underlying philosophy of the Government of Canada's investments in research and development since 1996. As you will discover in this report, these investments are helping to transform Canada into a more innovative and competitive nation in the global economy.

The federal science and technology efforts, extending over 21 science-based departments and agencies, are an essential part of Canada's innovation network. We have built an impressive record of creative partnerships with business and universities while continuing to support the federal government's important work in the creation and application of new knowledge and protection of the public interest. There has also been a growing role for federal laboratories in nurturing technology clusters as instruments of regional innovation.

In 1996 when the federal government released *Science and Technology for the New Century — A Federal Strategy*, we knew that sustained effort and investment would be necessary to achieve the goals of the strategy — sustainable job creation and economic growth, advancement of knowledge and an improved quality of life for all Canadians. Despite fiscal pressures and new security concerns, further investments in science and technology were announced in Budget 2001. Investments we make now in critical areas such as skills and learning, research and development, clean air and water, climate change and health care will benefit generations to come.

Our investments in science and technology provide an important foundation for *Canada's Innovation Strategy*, a blueprint for economic growth and prosperity over the next decade. *Investing in Excellence* is a starting point. We must ask ourselves: How can we do more of this, faster? How can we multiply our successes across the country and into the future? What do we need to do together — business, academia, all levels of government and Canadians — to build a stronger, more competitive country in the knowledge economy? *Canada's Innovation Strategy* seeks to answer these questions.

I encourage you to understand more about Canada's investments in science and technology and its role in our future as one of the world's most innovative countries.

Allan Rock
Minister of Industry

It has been five years since *Science and Technology for the New Century — A Federal Strategy* was released. Our scientists and researchers have built stronger links with colleagues and research partners in many departments, agencies and research councils. As well, the Government of Canada's science and technology (S&T) resources have been reoriented to make better use of the considerable pool of expertise that rests outside of government.

I am particularly proud of how the advice of the Council of Science and Technology Advisors has been taken up by scientists and policy makers. The government is currently implementing the Framework for Science and Technology Advice, which was based on the Council's work. The Council's most recent report, *Science and Technology Excellence in the Public Service (STEPS)*, has set out a valuable framework for ensuring and demonstrating the world-class quality of federal scientific activities. As Chair of the Council, I am committed to ensuring that the Council's principles of alignment, linkages and excellence are built on the foundation of a productive federal science and technology enterprise.

The federal S&T enterprise is a key player in Canada's innovation network. While *Canada's Innovation Strategy* already points to new ways of doing business (preserving and extending the principles of *Science and Technology for the New Century*), this new dialogue will be an opportunity to build on the investments of the past five years, as illustrated in this report, so that we continue to have a federal S&T enterprise in which we are confident and proud.

The Government of Canada is also developing new models for partnership and collaboration to change the way it carries out and delivers S&T. These models bring together important players in three S&T sectors — government, universities and the private sector — to improve and expand on research and development and innovation. Federal science-based departments and agencies are now integrating their capabilities with Canada's innovation system. These new models will help leverage resources from across federal departments to address major national policy issues.

This report shows we are on the right track, and we are moving well. It cautions, however, against complacency. The world is changing rapidly and, as the past year has shown us, often in unexpected ways. The federal science and technology enterprise must remain agile, not just to respond to these changes, but to anticipate them.

Maurizio Bevilacqua
Secretary of State
(Science, Research and Development)

INTRODUCTION

1.1 FOREWORD

This report, the fourth in the series, provides a five-year retrospective on the implementation of the federal government's science and technology (S&T) strategy, *Science and Technology for the New Century*, which was issued in March 1996. It traces the implementation of the strategy to show where we stand today. The strategy's principles have guided the federal enterprise in the transition to an age where knowledge is the key to responding to a broad range of public policy issues facing government and, indeed, society. These principles have also had a role in ensuring that Canadian industry is positioned to compete in the global marketplace.

This report takes a longer-term perspective, five years, allowing it to illustrate emerging trends. It is a collaborative effort of 21 science-based departments and agencies (SBDAs) and, as such, is a prime example of federal partnership and collegiality. It offers SBDAs an opportunity to showcase their major S&T achievements in the context of implementing the strategy.

1.2 SCIENCE AND TECHNOLOGY FOR THE NEW CENTURY: A FEDERAL STRATEGY, MARCH 1996

Science and Technology for the New Century recognized that the world's advanced economies were undergoing a fundamental transformation to a knowledge-based society. Although the S&T strategy was born in a time of fiscal deficits, the values it represents, as well as the checks and balances it employs, can serve federal S&T well through all fiscal periods. It strives to maximize the effectiveness and efficiency of federal S&T resources. And, it has resulted in new forms of collaboration and partnering.

Science and Technology for the New Century laid out a strategy for improving the federal government's S&T performance and enhancing the ability of the federal government to make its distinct contribution to the Canadian innovation system. The strategy set out three inter-related goals for building that innovation system: sustainable job creation and economic growth; improved quality of life; and advancement of knowledge. In addition, the strategy emphasized that while there

is a federal role in each of these areas, perhaps the most important federal role is supporting the dynamic interplay between the goals.

The core S&T activities outlined for the federal government in the strategy remain relevant today: funding and performing scientific research to support the mandates of departments and agencies; supporting research and training in universities, colleges, hospitals and other non-governmental research institutions and Networks of Centres of Excellence; and supporting private sector research and development (R&D). The strategy was also accurate in its depiction of emerging and critical new core activities: providing information and analysis, and building networks.

In proposing what amounted to a transformation in the way S&T was managed and used by the federal government, the strategy had two key themes. The first was improved governance: making better use of external advice, improving support to decision making, enhancing horizontal coordination, and making intergovernmental cooperation and coordination more effective. The second theme was improving the outcomes from federal S&T through the elaboration of a number of operating principles. These principles ranged from increasing the effectiveness of federally supported research and capturing the benefits of partnerships, to promoting a stronger science culture in Canada. The implementation of these themes and the operating principles are explored later in this report. *Science and Technology for the New Century* is available on-line (**http://strategis.gc.ca/pics/te/e-strat96.pdf**).

1.3 THE 2001 REPORT ON FEDERAL S&T

This report documents how the 1996 S&T strategy (in combination with a range of other factors) has shaped a new way of doing business for federal S&T. It is organized into five chapters, each with a particular focus.

- The remainder of this chapter (**Chapter 1**) sets out the more recent context that continues to shape federal S&T. It outlines the R&D and innovation challenges for Canada delivered in the 2001 Speech from the Throne. The place and role of the federal government in the national innovation system is explored.
- **Chapter 2** provides a five-year retrospective on the implementation of the federal S&T strategy. It includes a review of the new mechanisms of governance for federal S&T (part 2a) and the operating principles for S&T policies and programs (part 2b).
- **Chapter 3** provides a statistical overview of changes in federal S&T expenditures over the past five years and other quantitative and qualitative indicators.
- **Chapter 4** addresses future challenges and opportunities for federal S&T.
- **Chapter 5** concludes the main body of the report.
- The **Annexes, Highlights of Departmental and Agency Performance**, outline the SBDAs' achievements in implementing the S&T strategy between 1996 and 2001.

1.4 TODAY'S CONTEXT

We live in an age of science, an age where discovery and innovation are major engines of economic growth and where advances in scientific research hold out the greatest promise to improve the human condition.

The impact of S&T in this new century shows no sign of diminishing. The challenges that face our planet, economic and health disparities, the environment, the sustainable development of natural resources, bio-terrorism, human health and disease, all depend for their solution on sustained public investment in research and innovation. The scientific process itself is also one that only flourishes in an environment that rewards excellence, trains sufficient numbers of highly qualified people and recognizes the intrinsically long-term nature of the research enterprise.

The federal government has clearly recognized the important roles that science and innovation can play in underpinning future economic growth. It has also clearly recognized its central role and the opportunity in developing and sustaining a research enterprise that is connected to broader social and economic objectives. The creation of the Canada Foundation for Innovation in 1997, followed by the Millennium Scholarships, Canada Research Chairs Program, Genome Canada and, most recently, the Canadian Institutes of Health Research and the Canadian Foundation for Climate and Atmospheric Science, are clear signals that federal investment in research and innovation are seen as integral to public policy in Canada.

This report looks back over the five years since the release of the federal S&T strategy. As we look to the future, it is useful to take stock and examine the more recent past and the forces that have shaped the federal policy scene since the release of *Forging Ahead*, the last report on federal S&T. Over the past year, we have seen an economic slowdown, exacerbated by the events of September 11, 2001. National priorities have shifted and government finances are being constrained by increased spending on the safety and security of Canadians. This focus on security has made federal S&T perhaps even more important to Canada's quality of life and economic growth, but it has also limited the scope for bold new initiatives. The current environment highlights not only the need for the government to encourage and support innovation, but also the importance of the government being innovative in delivering on its mandates.

Recognizing the fundamental importance of science, technology and innovation as some of the foundations for a prosperous economy of the future, the government has continued to clearly state the priority that it attaches to them.

1.5 SPEECH FROM THE THRONE, JANUARY 2001 — A BOLD CHALLENGE TO ALL CANADIANS

Innovation was one of the key, overarching themes in the Speech from the Throne. The federal government laid out a bold objective — to be recognized as one of the most innovative countries in the world. The speech noted that achieving this goal will require a comprehensive approach and the support and participation of all governments, businesses and educational institutions.

The Speech from the Throne, January 2001

"We must strive for Canada to become one of the top five countries for research and development performance by 2010. This is a challenge for all Canadians, but in particular for the private sector as the largest research investor in Canada.

As its contribution, the Government will at least double the current federal investment in research and development by 2010. In making new investments, the Government will:

- *continue to pursue excellence in Canadian research by strengthening the research capacity of Canadian universities and government laboratories and institutions;*
- *accelerate Canada's ability to commercialize research discoveries, turning them into new products and services; and*
- *pursue a global strategy for Canadian science and technology, supporting more collaborative international research at the frontiers of knowledge."*

The speech also highlighted the government's intention to make new federal investments with a focus on strategically targeted research that is coordinated with partners. There was reference to investments that would directly benefit Canadians in areas such as health, water quality, the environment, natural resources management and oceans research.

The importance of research in the life sciences, which will benefit all of Canada, was a major theme in the speech. It stressed the role that research plays not only in major centres, but also its importance for agricultural and rural economies. For example, the government committed itself to helping the agricultural sector take a longer-term, future-oriented perspective, leading to more genuine diversification and value-added growth, new investments and employment, better land use, high standards of environmental stewardship and food safety.

1.6 FEDERAL, PROVINCIAL, TERRITORIAL COLLABORATION

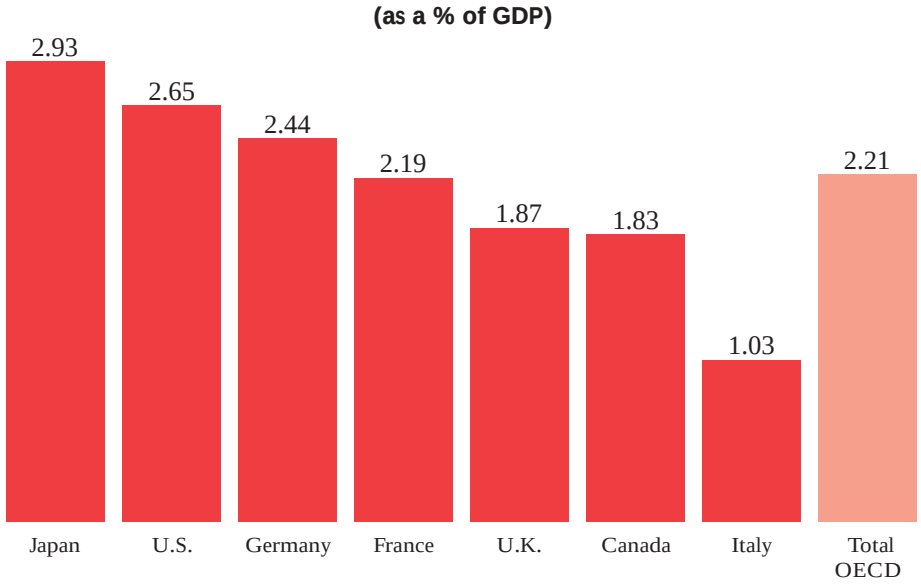
The federal government is a critically important part of Canada's innovation system. However, in an era of complex, multidisciplinary issues that do not respect borders and jurisdictions, cooperation and collaboration are essential. In this respect, federal, provincial and territorial ministers responsible for research and S&T met in Québec City in September 2001, to discuss ways to improve R&D performance and make Canada one of the most innovative countries in the world.

The ministers all agreed that reaching this shared objective is a tremendous challenge for all Canadians and will require complementary efforts and approaches on the part of all governments. Ministers acknowledged that the federal, provincial and territorial governments would have to work together to reach their objective. Ministers agreed on the need to consult and collaborate on initiatives, to take full advantage of the distinctive features of provincial and territorial innovation systems.

1.7 R&D SPENDING GROWING — BUT NOT FAST ENOUGH

International comparisons still indicate that Canada is underinvesting in R&D. The Organisation for Economic Co-operation and Development (OECD) reported that our overall investment in R&D was about 1.83 percent of GDP in 1999, a level that ties us for fourteenth in the OECD, and one that leaves us in sixth position among G-7 nations

Figure 1: R&D Expenditures, 1999



Source: OECD Main Science and Technology Indicators, November 2001.

(Figure 1). The leading nations spend closer to 3 percent of their GDP on R&D. Moreover, all leading nations are investing heavily in R&D as a basis for economic growth, so we are "chasing a moving target."

Statistics Canada estimates that R&D spending in Canada was $19.1 billion in 2000, an increase of 10.9 percent over the previous year. Spending on R&D by the federal government accounts for about $3.47 billion, or about 18 percent of the total. The government itself performs a smaller amount of this total ($1.9 billion, or about 10 percent of the total). Federal funding and performance of R&D, while not dominant in the innovation system,[1] is critical to the long-term growth of our economy and the quality of life enjoyed by Canadians. In this regard, the Speech from the Throne commits the government to at least doubling the current investment in R&D by 2010. Federal spending on R&D and other forms of S&T cannot in itself propel Canada to be among the top five in the OECD. However, strong federal S&T is essential to allow the other parts of the innovation system to play their respective roles. The ability of the government to protect the public interest and ensure the proper functioning of the economy is more and more dependent on the ability to generate and/or access the best possible scientific knowledge.

For Canada to be one of the top five countries in the OECD by 2010, the Natural Sciences and Engineering Research Council (NSERC) estimates that between 107 000 and 139 000 new researchers will be required across all disciplines. Through the three granting agencies,[2] federal investments in the training of highly qualified people are key to meeting this challenge and unlocking Canada's R&D potential.

1. The private sector funds about $8.1 billion and performs $10.9 billion, and the higher-education sector funds $3.1 billion and performs $5.9 billion.

2. The three granting councils are NSERC, the Social Sciences and Humanities Research Council and the Canadian Institutes of Health Research.

The federal science work force faces the same demographic challenges that are being tackled in other parts of the economy, both in Canada and around the world. In 1999, the Auditor General estimated retirements of federal researchers to be between 2500 and 3300 over the next five years. Significant work has been done to understand the particular challenges facing the public service. This issue is examined in greater depth in Chapters 3 and 4.

1.8 GOVERNMENT SCIENCE CAPACITY FOR STEWARDSHIP AND ECONOMIC DEVELOPMENT

The ability of the government to apply scientific advice to its policy, stewardship and economic development challenges is critical to the innovation system's ability to function efficiently. Government science provides the advice needed to inform economic and social decision making. On another front, the ability of government regulators to make timely decisions, based on sound scientific advice, is critical not only to the protection of our citizens and our environment, but also to firms. If firms cannot get timely, science-based government decisions on approving new products and services, then they will seek out other jurisdictions. Not only are the economic and scientific opportunities based on those new products lost to Canadians, but so too are the opportunities that are presented by the application of those ideas in society. For example, persistent delays in approvals of new drugs could convince the drug makers to relocate out of Canada. Canada would lose not just the R&D performed by those firms and the economic returns from the production of the drugs, but it is also possible that Canadians needing innovative new drugs could face substantial delays in receiving them. Similarly, delays of pest-control products could affect the competitiveness of Canada's food producers.

Government research needs to be conducted to the highest standards. This requires a dynamic and challenging research environment, which will attract excellent people. Government research facilities need to be competitive in quality and equipment with universities and the private sector, as researchers are all drawn from the same pool. Equally important, federal departments need to be able to invest new resources to meet the challenges of the future, e.g., policy advice, support for departmental missions, and economic development. Federal research labs need modern facilities and equipment, as well as highly skilled research personnel, to keep pace with the rapidly changing technological landscape, which they must formulate policy for and regulate. Resources are also needed to keep these facilities operating at productive levels. With research and scientific advice available from such a wide range of sources in the knowledge-based economy (KBE), governments need to be able to draw on the best available sources of knowledge, from both within and outside the federal system. This requires not only close linkages with all parts of the innovation system, but also fundamental capabilities to participate in research partnerships, and interpret and direct research activities.

The Council of Science and Technology Advisors (CSTA) and several other non-government organizations have expressed concern about the deterioration of the government's S&T capacity and the broader implications for innovation in

Canada. To reduce the strain on government resources, the CSTA encouraged government departments and agencies to continually examine their work agendas to ensure that they are not performing S&T that falls outside their departmental mandates and/or broader government priorities. However, the CSTA also noted that new S&T investments would likely be needed to support the ongoing functions of government; to provide the new capacity to respond to emerging science-based challenges and opportunities; and to ensure that the government's critical role in the innovation system is properly carried out.

FIVE-YEAR RETROSPECTIVE ON THE IMPLEMENTATION OF THE FEDERAL S&T STRATEGY

2a.1 NEW INSTITUTIONS AND MECHANISMS OF GOVERNANCE

Institutions matter. The institutions that guide and carry out S&T, and the way in which they are arranged and function together, can either encourage or impede invention and the exchange of ideas. Innovations in a country's S&T infrastructure can be as important as the innovations in science, engineering and technology themselves.

Other G-7 nations have well-established S&T governance infrastructures linking government, business, finance and academic institutions. Developing such an infrastructure is particularly important for a mid-sized country like Canada. We must be able to work more proficiently to compete in the global marketplace. This means taking a cooperative, coordinated and strongly networked approach to make the best use of our limited resources.

Advances in S&T are occurring so rapidly, and they carry such potential for systemic economic and social change, that the government must be able to consult with the best-qualified advisors in Canada and internationally from the scientific, industrial, financial, social, legal and economic communities. The government needs regular, direct access to these advisors to help identify emerging issues and priorities, and to obtain their views on proposed new policy directions.

Improving top-level advisory and decision-making structures is not sufficient to ensure that the federal government's substantial investment in S&T will yield better results. The federal S&T strategy recognized that the government must also put in place new institutions and mechanisms to improve the management of that investment.

Since 1996, the government has made substantial strides in reshaping its S&T institutions and mechanisms of governance. There has been a shift from "industry advisory boards" to much more inclusive "science advisory bodies" (SABs). All departments have adopted a far more structured approach to receiving and acting on scientific advice. The government, up to the Cabinet, has taken a more proactive approach to ensuring that it receives broadly based advice on horizontal S&T issues. The result, as

A New R&D Agency

As of April 1, 2000, the Defence Research and Development Branch of the Department of National Defence ceased to exist and became a departmental agency known as Defence R&D Canada (DRDC). The launching of DRDC as a new agency comprised of a national network of defence research establishments and employing over 1000 people, marks the beginning of a new and promising road ahead for Canadian defence S&T. Agency status provides opportunities for change that will help the government respond to new national security challenges in a rapidly evolving environment. The new structure, business processes and innovative approaches to the management of S&T will help DRDC enhance core competencies, develop new technologies, enter into diverse partnerships and increase efficiencies of operations.

described below, is a system that is more open, transparent and responsive to national needs.

2a.2 ADVISORY COUNCIL ON SCIENCE AND TECHNOLOGY

The Prime Minister's **Advisory Council on Science and Technology** (ACST) was established on July 5, 1996. The council is a cornerstone of the government's S&T strategy, *Science and Technology for the New Century*. It provides the Prime Minister with expert, non-partisan advice on national S&T goals and policies, and their application to the Canadian economy. Specifically, the council is mandated to review the nation's performance in S&T, identify emerging issues and advise on a forward-looking agenda. The ACST, which is chaired by the Minister of Industry, consists of eminent Canadians with significant S&T experience and knowledge, who have been appointed by the Prime Minister to provide advice to government.

The ACST's role is to:

- advise on the transition to a KBE and assist in determining the necessary adjustments;
- advise on how to increase the number of Canadians with the skills necessary for a KBE;
- advise on how government and industry can work in partnerships to incorporate new technology into marketplace products, processes or services;
- provide direct advice on S&T issues to the Cabinet Committee for the Economic Union (CCEU); and
- respond to specific questions or tasks requested by the Prime Minister.

The ACST meets with the CCEU to plan its program and report its findings. Since its inception, the council has met with the CCEU four times. As a result of recommendations made by the ACST to the CCEU, the ACST now has the ability to establish expert panels, when appropriate. The expert panels provide a relatively quick but in-depth examination of important S&T issues.

The Expert Panel on the Commercialization of University Research was created in the fall 1998. The panel's mandate was to provide independent, expert advice on options to maximize the social and economic benefits to Canada from the public investment in university research. The panel completed its work in May 1999, and presented its findings in a report entitled, *Public Investments in University Research: Reaping the Benefits*. The ACST has recommended that the federal government implement the expert panel's recommendations. In the federal budget of December 10, 2001, the government indicated that it was "…also committed

to promoting the commercialization of research through university and private sector partnerships and consortia."

In the fall 1998, the ACST also created the Expert Panel on Skills. The panel was asked to provide independent, expert advice on the critical skills needed in a number of sectors of industry where Canada is strong, or where opportunities for economic growth and for job creation are high. These sectors are aerospace; automotive; biopharmaceuticals and biotechnologies in agriculture, aquaculture and forestry; environmental technologies; and information and telecommunications technologies. The panel was asked to report on the following three fundamental issues, particularly as they apply to a number of knowledge-intensive industrial sectors:

- What critical skills will be needed over the next decade to improve or maintain Canada's competitive position?
- Are these critical skills in short supply currently and in the foreseeable future, and do we have appropriate means to monitor their availability?
- What practical approaches and strategies could help ensure that Canadians acquire and develop the critical skills necessary to succeed in a KBE?

The panel submitted its report, *Stepping Up: Skills and Opportunities in the Knowledge Economy*, to the ACST in October 1999. The ACST presented the report to ministers, along with recommendations for action. These were referred to Human Resources Development Canada (HRDC) for review. The panel's report provided the impetus for three national roundtables sponsored by HRDC in the winter and spring of 2001, to engage a wide range of stakeholder groups on the skills and learning challenges that confront Canada in the 21st century. These initial and ongoing consultations have helped to move the Skills and Learning Agenda forward.

The Expert Panel on Canada's Role in International S&T was established on May 27, 1999, to advise on options for maximizing the social and economic benefits to Canada, resulting from its involvement in international S&T. It submitted its report, *Reaching Out: Canada, International Science and Technology, and the Knowledge-based Economy*, to ACST in June 2000. The report was reviewed by ministers in the fall of that year. In the Economic Statement and Budget Update of October 18, 2000, $100 million was allocated to the Canada Foundation for Innovation to "support the participation of Canadian researchers in major international research projects."

The ACST has also prepared one report itself without using an expert panel, *Creating a Sustainable University Research Environment in Canada*. In the report, ACST examined the issue of support for federal payment of the indirect costs incurred by universities to support the research undertaken by their researchers that was sponsored by the federal government through the three granting councils. Earlier ACST reports had also raised this issue but without extensive analysis. This report was released in September 2001. In the federal budget of December 10, 2001, the government made a one-time investment of $200 million through the granting councils to Canada's universities to "help alleviate financial pressures that are associated with federally supported research activity at universities and research hospitals. This initiative will help support world-class

research facilities and respond to the needs of Canada's smaller universities in their efforts to become more research-oriented."

In the same budget, the government indicated that it is also "committed to promoting the commercialization of research through university and private sector partnerships and consortia. Looking ahead, the government will work with the university community on ways to provide ongoing support for indirect research costs that is predictable, affordable and incremental to existing support."

All ACST reports are available in both official languages at the council's Web site (**http://acst-ccst.gc.ca**).

2a.3 COUNCIL OF SCIENCE AND TECHNOLOGY ADVISORS

The federal S&T strategy's call for greater reliance on external advice resulted in the creation of the Council of Science and Technology Advisors (CSTA) in 1998. The CSTA provides the federal government, specifically the CCEU, with external expert advice on internal federal government S&T issues requiring strategic attention.

The CSTA consists primarily of representatives from SABs, who report to the SBDAs. The CSTA draws these advisors into a single body to improve federal S&T management by examining issues common to a number of departments, and by highlighting opportunities for synergy and joint action. Chaired by the Secretary of State for Science, Research and Development, the CSTA is tasked by the CCEU.

Since its inaugural meeting in April 1998, the CSTA has undertaken a series of reviews of the federal S&T system and has issued a number of reports that have had a significant impact on the way federal S&T is conducted and managed. The CSTA's first report, *Science Advice for Government Effectiveness* (SAGE), released in May 1999, recommended a set of principles and guidelines for the effective use of science advice in decision making.

The government responded to the SAGE report by issuing *The Framework for S&T Advice in Government Decision-Making*, on May 31, 2000. This framework is in place to ensure that government policy, and regulatory and management decisions are informed by sound S&T advice. The framework is derived from the SAGE report, and reflects extensive consultations within government and with external stakeholders. SBDAs are actively implementing the framework, to ensure accountability for the principles and guidelines across government.

The CSTA published its second report, *Building Excellence in Science and Technology* (BEST), on March 22, 2000. This report addressed the roles of the federal government in performing S&T and its capacity to deliver on those roles. The principles outlined in the BEST report focused on the alignment of activities with departmental mandates and government directions, linkages within the government and to other players in the innovation system, and excellence. The report concluded that the Government of Canada needs to maintain a strong in-house capability in S&T to ensure the present and future well-being of Canada, its people and its environment.

The BEST report stressed that the federal government is an important player in Canada's innovation system, but encouraged departments and agencies to ensure that they were not carrying out work that could be better achieved outside of government. BEST stressed the

Recommendations of the CSTA STEPS Report:

1. Implement the Framework

2. Quality

Employ external, expert review processes to support project selection, and assess the results of federal S&T. The report reaffirms the commitment made in the 1996 federal S&T strategy to engage clients, stakeholders and peers in review processes.

3. Relevance

In the context of existing program evaluation mechanisms, involve external science advisory bodies in assessing the relevance of departmental S&T programs. Science advisory bodies should call on departments to demonstrate the requirement for the S&T, the need for the S&T to be conducted in-house, and the department's ability to perform it to standards of excellence. The Government of Canada should ensure that its S&T is useful to and useable by its clients.

4. Transparency and Openness

Include communications and publications strategies in program and project planning documents, and require departments to publish, or otherwise make available to the public, information on all funded S&T projects. The Government of Canada should involve stakeholders throughout all stages of the S&T continuum. Departments should be explicit and transparent with respect to the mechanisms they use to assess their S&T.

5. Ethics

The Government of Canada should develop and implement government-wide guidelines to ensure the ethical conduct of federally performed S&T.

need to involve all stakeholders in planning, implementing and assessing federal S&T activities.

To perform its many roles well and to maintain credibility with stakeholders and the public, the government must ensure and must be able to demonstrate that the S&T it conducts is excellent. In April 2000, the CCEU asked the CSTA to build on its previous reports and conduct an examination of excellence in federally performed S&T.

The CSTA released its third report, *Science and Technology Excellence in the Public Service* (STEPS), on August 16, 2001. The report identifies the distinguishing features of federally performed S&T and offers a framework for excellence in government S&T. The framework reflects the unique characteristics of excellence that distinguish government S&T from the S&T performed in other sectors. It is built on a foundation of conditions essential for excellence and on four pillars that define the elements of federal S&T excellence: quality, relevance, transparency and openness, and ethics. The report also identifies mechanisms to measure excellence in the conduct and management of federal S&T. Lastly, it offers recommendations on how the framework can be employed to foster excellent S&T.

At the recommendation of CSTA members, an examination of the mandates and operating parameters of external departmental science advisory bodies (SABs) was conducted. SABs bring relevant knowledge and expertise to S&T issues and offer departments a source of advice on broader policy issues from an S&T perspective. The report, *Reinforcing External Advice to Departments* (READ), was released in spring 2001.

The report revealed that SABs are valued by SBDAs for the high-calibre, relevant and candid advice they provide. READ offers a model that identifies a series of characteristics and practices to maximize and capitalize on the contribution of external departmental SABs. The model provides guidance for the operation of departmental SABs, while recognizing the unique character and qualities of

individual SABs, departmental mandates, priorities, structures and operating principles. The model is a tool that can foster more open, dynamic and productive relationships between SBDAs and SABs.

Next Steps

At the request of the CCEU, the CSTA is building on its past reports and conducting examinations to:

- identify the challenges unique to the renewal of federal S&T personnel, and recommend practices and policies to address these challenges, and
- identify the unique characteristics and challenges involved in the communication of federal S&T and offer recommendations to improve effectiveness.

The S&T human resources examination will complement ongoing internal efforts to renew capacity and will strive to contribute to the work of the Task Force on Modernizing Human Resources Management in the Public Service. The communications challenge will consider the increasing importance of S&T communications, as complex and controversial science-based issues move to the centre of decision making for citizens, industry and government.

The CSTA's reports and their findings are having a positive impact, with a number of SBDAs independently moving forward on report recommendations. The reports, as well as supporting documents, can be found on the CSTA Web site (**http://csta-cest.gc.ca**).

2a.4 ADM COMMITTEE ON SCIENCE AND TECHNOLOGY

Following the release of the S&T strategy, the government moved to strengthen its internal capacity for S&T information-sharing and coordination. The existing Assistant Deputy Ministers' Steering Committee on the Management of Federal Science and Technology was renamed the ADM Committee on Science and Technology. The committee adopted the following new mandate:

- to implement the cross-government commitments made in the S&T strategy, i.e., the wise use of federal investments in S&T and the sharing of best practices;
- to develop proposals and advice to the government on key horizontal S&T policy issues; and
- to provide a forum for interdepartmental consultation on S&T policy and program directions, sharing of information, and coordination of efforts and initiatives across the federal S&T system.

The committee is made up of ADM or equivalent-level representatives from departments and agencies with S&T activities and/or interests. The committee counts as its first success in this mandate the S&T strategy itself, notably, the ability to reach a consensus within the federal S&T community on the strategy's directions and principles. With the strategy in place, the ADM Committee has helped to develop a stronger sense of community across federal S&T, fostering information-exchange and raising the profile of S&T issues within the government. The series of reports on federal S&T (of which this is the fourth) is another example of SBDAs coming together to take a more horizontal view of federal S&T.

The interchange of information and ideas fostered by the ADM Committee has paved the way for increased cooperation

and collaboration between departments and agencies. Not only is there increased discussion of individual departmental policy proposals, but there is now a desire to address shared issues across departments and agencies. The committee has provided Cabinet with a clear and comprehensive picture of the federal S&T effort, and is currently working to create new mechanisms for addressing national S&T needs in ways that integrate capabilities across the federal government and across the innovation system.

2a.5 THE INFORMATION SYSTEM FOR S&T PROJECT (STATISTICS CANADA)

In March 1996, the Minister of Industry funded the implementation of one of the recommendations of the Working Group on Science and Technology Statistics: The Information System for Science and Technology Project at Statistics Canada. The initial three-year project was extended to March 2003, with the support of the federal Policy Research Initiative (PRI). The indicators that the project has developed or improved since 1996 provide a background against which federal government departments and agencies can measure how effectively they are applying the operating principles of the federal S&T strategy. These indicators complement the measures used for accountability and priority setting within individual departments and agencies and across government. In addition, they begin to show how the Canadian S&T system works.

The project has developed or improved indicators for R&D, invention, innovation, technology use and human resources in each of these activities. Linkage indicators include the following:

- the sources of ideas and technologies used by firms to produce new products or processes,
- the commercialization of intellectual property of universities and government laboratories, and
- the collaboration between firms, universities and government departments.

Outcomes such as changes in employment can also be measured in relation to an activity. In addition, with enough information from several sources, gathered over a period of time, there can be analyses of the impact of the activity on the economy and on society. Impact analysis is a long-term objective.

The Federal Science Expenditures and Personnel Survey provides an answer to the question, "*How much* does the federal government spend on S&T?" It also allows the data to be shown by geographic region. For extramural expenditure, it includes the industries that received the contributions, grants or contracts. These are answers to the question, "*Where* does the federal government spend its S&T money?" The data can also be tabulated by socio-economic objective to answer the question, "On *what* does the federal government spend its resources?" Looking at the most recent data, the leading three socio-economic objectives are the following:

- industrial production and technology
- agriculture production and technology
- public health.

The answers to the three questions above contribute knowledge that can enhance the governance mechanisms of federal S&T activities, by showing what is being allocated, where and for what reason.

The Information System for Science and Technology Project does more than measure federal S&T activities. It covers all sectors of the economy, with a particular focus on the linkages between the actors in the S&T system and the outcomes that result from the activities. Examples include the surveys of innovation in selected service industries in 1996, and of advanced-manufacturing-technology use in 1998. In addition, another survey, R&D in Canadian Industry, produces data on R&D devoted to biotechnology, computer software, and pollution abatement and control. Results of these surveys are made widely available through Statistics Canada's catalogued publications, research papers, working papers, seminars and briefings.

To develop foresight, the project also conducts research workshops that look at innovation from diverse perspectives. The first workshop focused on geography and gave rise to the Innovation Systems Research Network. The next two looked at transforming technologies, specifically, information and communication technologies (ICTs) and biotechnology. Both contributed to work of the OECD on defining and measuring technology production and use, and led to more internationally comparable data that are necessary inputs to the policy process in Canada. The most recent workshop was on knowledge management. It led to an OECD pilot survey of knowledge management practices. The Canadian version of the survey will report results in the first half of 2002. Each of the workshops has yielded new information that contributes to the ongoing public policy debate in Canada and abroad.

In addition to PRI funding, the work on biotechnology at Statistics Canada was expanded and supported from 1999 to 2002, as part of the Canadian Biotechnology Strategy. In tandem with this initiative, the Socio-Economic Indicators of Connectedness Project was launched with PRI support, and it developed new indicators of the use and application of ICTs.

Since April 1999, the project has grown and has drawn in collaborators from the NRC, NRCan, and Industry Canada to work on innovation and technology use. The Association of Universities and Colleges of Canada (AUCC) and several universities collaborated on measuring commercialization of intellectual property in the higher-education sector. The recent work on knowledge management has involved Defence R&D Canada, Health Canada, HRDC, Industry Canada, the Institut de la statistique du Québec, the NRC, NSERC, SSHRC and the Treasury Board Secretariat (TBS). Collaborators are involved in all aspects of the project, from questionnaire design to workshops and data analysis.

To encourage the use of the new data, Statistics Canada developed a program of Facilitated Access to the microdata for academic and government researchers. As with Statistics Canada's Research Data Centres, which currently deal with social statistics, a research proposal is submitted. If the proposal is accepted, the researchers are trained and given access to the survey data in a way that respects the confidentiality requirements of the *Statistics Act* and covers the cost of the access. Results of facilitated access to the innovation surveys have been used to brief the Minister of Industry and by the Conference Board of Canada in its second innovation report.

Statistics Canada and Industry Canada held a joint international workshop in November 2001 to take stock of the findings and policy implications of the Survey of Innovation 1999. To continue the exploration of factors affecting innovation, the U.S. National Science Foundation co-sponsored another workshop with Statistics Canada in March 2002 on alliances, networks and partnerships. These activities play an essential role in guiding the project's activities in supporting the analysis of technological change in Canada.

2a.6 THE HUMAN RESOURCES MANAGEMENT FRAMEWORK FOR FEDERAL S&T

Human resource (HR) issues confronting federal scientists, engineers, technicians and technologists have been the focus of sustained study and experiment for over six years, beginning with a chapter in the 1994 Auditor General (AG) report on the management of federal scientific personnel. Cross-departmental working groups were established to study different horizontal HR issues. These groups led to a sharing of best practices and provided the basis for TBS's 1996 report, *Framework for Human Resources Management of the Federal Science and Technology Community*, which served as a background paper to *Science and Technology for the New Century*. The framework was part of TBS's response to the Public Accounts Committee, concerning the AG's findings. It was designed to help the government develop and implement a practical set of policies and cost-effective tools for science managers to use in aligning their organizations and their S&T staff with the science direction of departments. The framework also became the commitment for departments, central agencies and bargaining agents to work together, using problem-solving approaches to resolve S&T HR issues.

An S&T ADM committee on HR was established in 1995. Over the years, the ADM committee provided a sounding board for discussions, provided direction, ensured compatibility of recommendations, and decided on recommendations for implementation at either the departmental or cross-departmental level. The Professional Institute of the Public Service of Canada also participated.

TBS also established an S&T secretariat to serve as the focal point, catalyst, control centre and support unit for the framework. This office was also established to pull together the material for the working

Graduate Opportunities Strategy (GOS)

As the competition for highly skilled scientific personnel increases on a global level, federal government science departments are presented with both a challenge and an opportunity. The opportunity is to examine ways to be more flexible within the existing system, and to re-establish the Government of Canada as an "employer of choice" among highly skilled scientific professionals.

In May 2001, the Treasury Board Secretariat agreed to fund a one-year pilot program called the Graduate Opportunities Strategy (GOS). It provided excellent opportunities for personal and professional growth, and an opportunity to bring in recent graduates with current skills and training.

The $3.62-million fund was established and managed by the S&T Community Secretariat, and it provided funding to seven federal science-based departments for one year. The pilot focused on the recruitment of research scientists and engineering support technologists. The funding was pro-rated by each department's current population and, by December 2001, the target of 65 new hires had been surpassed.

groups, support the ADM committee and respond to the AG in a cohesive fashion.

In 1997, two important changes occurred. First, as part of its efforts to renew the federal Public Service, the government formed the Deputy Minister-level Committee of Senior Officials (COSO) S&T Subcommittee. Then, as a result, the existing ADM committee became the *de-facto* subcommittee of the COSO S&T Subcommittee, and community management[3] gained prominence as an effective horizontal human resource management approach.

In 2000, the ADM committee adapted to a new role under the framework. It changed from a formal steering committee to an active advisory committee and is now more involved in community management as an advisor, partner and primary stakeholder.

3. "Community management" is interchangeable with the more recent term "community renewal."

2b.1 OPERATING PRINCIPLES FOR S&T POLICIES AND PROGRAMS

To ensure that departments and agencies act together to reach S&T goals, the S&T strategy adopted a common framework of operating principles. The government-wide framework guides departments and agencies in preparing and implementing their S&T plans. The operating principles for S&T policies and programs are as follows:

- to increase the effectiveness of federally supported research,
- to capture the benefits of partnership,
- to emphasize preventive approaches and sustainable development,
- to position Canada competitively within emerging international regulatory standards and intellectual property regimes,
- to build information networks, the infrastructure of the knowledge economy,
- to extend S&T linkages internationally, and
- to promote a stronger science culture.

The ways in which departments and agencies apply these principles to their S&T activities vary, depending on their roles and responsibilities. Similarly, not all the principles apply equally to all departments. The operating principles are the qualitative benchmarks against which results can be measured and evaluated. The text below (2b.2 to 2b.8) examines the operating principles for S&T policies and programs.

2b.2 INCREASING THE EFFECTIVENESS OF FEDERALLY SUPPORTED RESEARCH

The strategy identified four closely interlinked elements associated with increased effectiveness: scientific excellence, relevant lines of inquiry, full value for money, and the transfer of knowledge and technology.

Since the publication of the federal S&T strategy, all federal SBDAs have taken steps to increase the effectiveness of federally sponsored research. These steps range from new planning and reporting mechanisms, to the institution of systems of expert review, client surveys, impact studies, partnership building and benchmarking.

The CSTA's reports on federal S&T have given the government valuable guidance, especially in the areas of excellence and

relevance. Two of their reports focused specifically on the issue of federal S&T excellence: *Building Excellence in Science and Technology* (BEST) and *Science and Technology Excellence in the Public Service* (STEPS).

The CSTA noted that science performed in the public interest should not always be judged by the same criteria as that performed by the private sector (impact on the bottom line) or the academic sector (peer review). Instead, it should be judged according to criteria designed to meet the public's interest, and the STEPS report outlined several approaches to be used by departments to ensure S&T excellence. Through project reviews, in-house assessment, competitive proposal-submission processes, expert review panels and client satisfaction surveys, federal departments benchmark and measure their pursuit of excellence in science.

Pursuing relevant lines of inquiry is essential for SBDAs to address government and departmental priorities, and to ensure that Canadians' expectations are met. By following the criteria of relevance, departments can relate their own scientific priorities to those of other departments and science-performing organizations in other sectors, thus avoiding duplication of effort and setting the stage for collaboration. Since the introduction of the S&T strategy, R&D priority-setting has taken on new levels of importance within the federal government. New R&D initiatives associated with climate change, biotechnology and toxic substances, for example, have instituted extensive and explicit R&D priority-setting processes to ensure adherence to relevant lines of inquiry.

The establishment and/or restructuring of external S&T advisory boards and technical review panels, as suggested in the strategy, has been a key mechanism used by departments and agencies to ensure the relevance of their S&T programs and activities. As highlighted in the CSTA's report *Reinforcing External Advice to Departments* (READ), SABs are effective in assisting departments in delivering on their science mandate by focusing attention on relevant lines of scientific inquiry. The report also found that there is no single model of external S&T advice that will meet the needs of all government departments.

Federal SBDAs have revised internal R&D planning processes to shift to emerging areas of high priority and exit from areas

Recognition for Federal S&T Excellence

One clear measure of scientific excellence is recognition through awards. With two Nobel prizes to its credit, federal government science has played an important part in Canada's long tradition of scientific excellence. The two federal Nobel Laureates are Bertram Brockhouse in Physics in 1994, and Gerhard Herzberg in Chemistry in 1991; and the awards continue.

NRCan Recipient of the NQI Canada Award for Excellence

In September 2000, Natural Resources Canada's Aeronautical and Technical Services (ATS) Division won the prestigious "Canada Award for Excellence." It is the first Government of Canada organization honoured by the National Quality Institute (NQI) for high-quality products, services and management. The awards were created in 1992 by NQI to recognize excellence in implementing quality principles and practices. ATS publishes Canada's official aeronautical charts and quickly produces the maps needed in national emergencies. ATS recently implemented new technology and digital products and services both to provide fast, first-rate service to their clients and reduce costs. It has met the ISO 9001 standard for effective and efficient operations since 1997.

of low priority. The federal Program on Energy Research and Development (PERD) has completely revised its system of R&D priority-setting in the past three years, placing new emphasis on a series of program objectives and making use of a rigorous system of funding allocation to ensure R&D synergy with program objectives. Federal granting councils have held targeted competitions for new Networks of Centres of Excellence, to direct university research towards areas of high priority.

Obtaining full value for money is not unique to the public sector as a criteria for effective science. The nature of R&D inquiry, however, means that efforts to guarantee full value for money are an elusive challenge. Numerous studies have shown, however, that the economic and social benefits from investments in research far outweigh the costs of research. Through partnerships and collaboration, federal science-performing institutions and universities can avoid duplication of effort and carry out scientific undertakings on a scale they could not do individually. New efforts to work horizontally across government in a wide range of R&D areas, including the conduct of science assessments, has helped to ensure that full value for money is being realized from federal S&T investment. Moreover, R&D impact-study assessments, which are now carried out in federal S&T departments, have helped to demonstrate the full value obtained from federal research investments.

Following the publication of the federal S&T strategy, some of the federal government's largest S&T performers, including Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada and Natural Resources Canada, signed a Memorandum of Understanding to Collaborate on S&T in Support of Sustainable Development. Now known as the 5NR MOU, and now including Health Canada, this initiative has led to cross-departmental working groups in a range of areas such as climate change research, metals in the environment, nutrients assessment and endocrine-disrupting substances.

Another mechanism widely exploited by the federal government to ensure value for money has been the formation of formal research networks. Networks foster research collaboration by mobilizing diverse S&T capacity and resources to address issues, problems, challenges or opportunities of common concern and interest to many SBDAs. Also, networks improve S&T excellence by avoiding duplication of activity and allowing the very best scientific talent and resources to be merged. They provide an easily accessible and recognizable focal point for scientific efforts that would otherwise remain disparate and uncoordinated. Lastly, they provide the national system of innovation with agility and flexibility, allowing multi-disciplinary teams to be assembled in a timely and responsive fashion.

Canada has been a world leader in the development of collaborative research initiatives and networks. A 1998 study by the International Institute for Sustainable Development, *Formal Knowledge Networks: A Study of Canadian Experiences*, documented Canada's relative advantages with respect to the development of knowledge networks through mechanisms such as the Networks of Centres of Excellence program, the Canadian Institute for Advanced Research, the Canadian Policy Research Networks, and the Canadian Network of Toxicology

Centres. Many other research networks, such as the Climate Research Network and the Atlantic Cooperative Wildlife and Ecology Research Network, are sponsored by the federal government. New research networking efforts are ongoing, with the development of initiatives such as the Canadian Climate Impacts and Adaptation Research Network. The Biodiversity and Innovation Knowledge Network was created in 2001, to address a need for an organized, well-resourced national approach to building and managing Canada's biodiversity information.

Another approach for ensuring value for money has been the effort by federal SBDAs to make active use of R&D impact analysis to assess the outcomes and results of federal S&T. The R&D Impact Network and the Program of Energy Research and Development's implementation of results-based performance measurement are two examples of how government is adopting these mechanisms to ensure relevance and value for money. The PERD is a competitive process administered by NRCan that provides funding for non-nuclear federal energy R&D. After reviewing PERD programming in 1999, NRCan negotiated a revised memorandum of understanding with the 12 participating federal departments and agencies, incorporating new accountability provisions and performance measures. Implementation of results-based performance management is leading to closer monitoring of the results of work conducted with PERD funds and better decision making on future resource allocations. The R&D Impact Network was established by NRCan, the TBS and other research partners to advance R&D impact assessment and provide research organizations with simple, credible and broadly accepted performance measurement tools for results-based management and decision making. The network has refined and adapted tools for measuring the social and economic impacts of R&D, developed strategies to communicate impact information and promoted the exchange of best practices. Many departments and agencies now routinely make use of R&D

Federal Partners in Technology Transfer (FPTT)

The Federal Partners in Technology Transfer (FPTT), established following the publication of the federal S&T strategy, is a forum for stimulating a productive and horizontal dialogue among various stakeholders on technology and knowledge transfer issues. By providing a forum for the right people to talk to each other and to collectively address common concerns, individual departments and agencies have saved both time and money and become more effective in their technology and knowledge transfer activities.

FPTT has established itself as an important vehicle for promoting best practices, entrepreneurial thinking, and information sharing on ways to enhance the professional capacity of its members.

Key to the success of FPTT are its members, highly skilled professionals who have provided the backbone to the FPTT infrastructure, which now includes several sub-committees (Promotechers, Intellectual Property, Training, R&D Impact Network, International IP Working Group). FPTT and its Advisory Council also work closely with other interdepartmental groups and have been approached by Foreign Affairs and International Trade Canada, and Industry Canada on improving technology transfer practices in international linkages.

The FPTT forum has provided invaluable contacts to its individual members. It has allowed for sharing of experiences and networks. At each meeting, the hosting department or agency gives a presentation on a successful initiative related to technology transfer within its organization (e.g. NRC's Entrepreneurship Program, NSERC's Research Partnership Programs, NRCan/CANMET's New Ventures Initiative, AAFC's Matching Investment Initiative).

impact analysis in addition to traditional audit and evaluation practices.

Outside the public service, the transfer of knowledge and technology has long been recognized as a desired end of the S&T effort. Under the S&T strategy, it is now also an important indicator of successful federal S&T. The transfer of knowledge and technology ensures that the benefits of federal investments in science are made available to the public, policy makers, business and the international science community. An increased focus on technology transfer and partnerships has improved the effectiveness of federal S&T by facilitating the movement of knowledge and intellectual property from researchers to developers, through the commercialization process and, ultimately, into the hands of consumers in the form of new goods and services. Since the launch of the S&T strategy in 1996, the federal government has repeatedly demonstrated its commitment to the transfer of knowledge and technology.

2b.3 CAPTURING THE BENEFITS OF PARTNERSHIP

Successful scientific and technological innovation is as much about relationships as it is about R&D. It can entail a variety of relationships, including:

- relationships between researchers and the peer community of experts in the private sector, universities or government research establishments,
- relationships between a supplier of technology and the end-user community, and
- relationships between the finance community, the regulators of an industry or sector, and policy makers in municipalities, provinces and federal departments and agencies.

In today's world of rapid technological change — change that is accelerated by the Internet and information technologies — the requirement for speed in developing and integrating new technological innovations is evident in the private sector. Often, the allowable time to market is a matter of months, if not weeks. In this environment, scientific support for the development of new regulations and standards must keep pace with rapidly evolving new technologies — and new models of partnerships are required.

S&T relationships can take different forms: networking and informal communications, project teams, and partnerships. In this report, a partnership is defined as a formal ongoing agreement between two or more organizations, where the primary objective is to develop new science in support of the federal government's innovation and scientific policy objectives. Partnerships can take the form of memoranda of understanding between Canada and other countries;

Matching Investment Initiative

Sectoral growth through technology development is one of the principal aims of Agriculture and Agri-Food Canada's Matching Investment Initiative (MII). The MII fits with other federal department programs in achieving this goal. For example, Industry Canada and the National Research Council operate Technology Partnerships Canada and the Industrial Research Assistance Program, respectively. These programs complement the MII, as they provide repayable contributions to support the downstream stages of R&D. Tax credits in Canada for R&D are among the most attractive of the G8 countries. If combined with MII, a company may offset up to two-thirds of its investments.

between the federal government and the provinces; within federal agencies; and between the federal government and other stakeholders in the private, not-for profit and academic sectors.

The Canadian federal government has a long tradition of partnerships in S&T, dating back to the early days of the Manhattan Project, where a strong partnership between Canada and the Allies was of fundamental importance for the development of nuclear energy technology in Canada.

Federal-Provincial Health Collaboration

An extensive collaboration between the Population and Public Health Branch, Biologics and Genetic Therapies Directorate reviewers and researchers, and provincial and territorial epidemiologists has shed light on the relatively high rate of ocular-respiratory syndrome associated with one manufacturer's vaccine for the 2000–2001 flu season. An enhanced monitoring of the rate of side effects associated with influenza-vaccine products from various manufacturers is being continued this year.

There is no single dominant motivator for developing an S&T partnership. The Conference Board of Canada's *Second Annual Innovation Report: Collaborating for Innovation* identifies access to expertise and R&D in government labs, as well as cost-sharing, as key motivators for forming partnerships between firms and government laboratories.

The Conference Board noted that, in collaborative R&D partnerships with government labs, business tends to most value the following:

- access to skill and knowledge,
- a strong applied research capacity,
- a willingness to collaborate,
- a good understanding of industry needs,
- the ability to manage large projects to industry standards and timetable expectations, and
- the linkages to international science.

Among Canadian (domestic) private and public sector partnerships, including research consortia, interdepartmental collaborations to combine resources and the sharing of federal research facilities with other researchers have become key operating principles and practices within the federal S&T system over the past five years.

For example, AAFC scientists and university professors work on joint research efforts provided through various MOUs. Arrangements are in place with many universities, including the Nova Scotia Agricultural College and the universities of PEI, Laval, McGill, Guelph, Saskatchewan and Alberta. AAFC researchers are also co-located with a number of universities, including Laval and Saskatchewan.

There are many examples of productive and effective partnership arrangements within federal S&T. For example, a close working relationship between the NRC's Institute for Aerospace Research and DND's Defence Research and Development Branch over the years has been instrumental in the development and long-term viability of the Armed Forces CF-18 Program. In another collaboration, the two partners have successfully developed the latest generation of computer fly-by-wire technology, which can be used in the operations of the Bell 4-12 Griffon Helicopter. The value of

The New Media Innovation Centre (NewMIC)

*NewMIC, located in Vancouver, has a mandate to stimulate and support the development and growth of the new media sector in western Canada. NewMIC is assembling a critical mass of scientific and technological expertise among scientists, industry and other stakeholders. Partners include Western Economic Diversification, the Province of British Columbia, the University of British Columbia, Simon Fraser University, the University of Victoria, TechBC Emily Carr, TRLabs, Advanced Systems Institute, Electronic Arts, Telus, Zerox, IBM, Sierra Wireless and Nortel. The new media sector presently employs more than 3000 people in western Canada and has the potential to expand by 50 percent over the next two years, with revenues of more than $1 billion. For more information, visit the NewMIC Web site (**http://www.newmic.com**).*

Metals in the Environment (MITE) Research Network

*A highly successful example of industry-university-federal collaboration is the Metals in the Environment (MITE) research network, initiated by NRCan and NSERC in 1998. Partners include DFO, EC, 14 Canadian universities, the Mining Association of Canada and other industry collaborators. The focus is on sharing and increasing our knowledge of the role and effects of metals in materials, air, water and soil throughout their life cycle, to support regulation and standards-setting in Canada and by international organizations. Benefits have included the cross-fertilization of expertise between multiple scientific disciplines, and the opportunity to work in the laboratories of other institutions and with other network members. Network activities include annual research symposia that are open to the public, workshops on emerging issues, publications in international journals and a newsletter. For further information, visit the MITE Web site (**http://www.mite-rn.org**).*

these collaborations resulted in a landmark MOU between the newly formed Defence Research and Development Canada and NRC in 2001, in which over 60 potential collaborative projects were identified in cutting-edge fields such as information technologies, biotechnology, battery and fuel cell technologies, and fire modeling.

The Toxic Substances Research Initiative is an innovative research partnership arrangement led by Health Canada and Environment Canada, launched in 1998 with the objective to enhance the knowledge base needed to define and reduce the risk of adverse effects of toxic substances on Canadians and their environment. The program addresses multidisciplinary research challenges with a focus on ecosystem health and groups at risk. It also seeks to promote public understanding and involvement through community consultation, communications and the use of research results.

The program has funded a total of 81 proposals during its three-year timeframe, in fields such as persistent organic pollutants, forms of metals in the environment, endocrine-disrupting chemicals, urban air quality, and the cumulative effects of toxic substances. For example, the Toronto Urban Spatial Variability Study is part of the Study of the Health Effects of the Urban Mix of Air Pollutants (SHEMP). Launched in 1999, the three-year SHEMP program collects daily measurements of key smog pollutants and the chemical composition of fine particulate matter, including organic pollutants, at fixed long-term study sites in Toronto and Vancouver. The information from the Toronto Urban Spatial Variability Study will be used to determine how representative fixed-monitoring sites such as these are in characterizing the population's exposure to air pollutants.

In December 1997, the Canadian Food Inspection Agency (CFIA) introduced the Canadian Partnership for Consumer Food

Safety Education, with membership from industry, consumer groups, the CFIA and other government agencies. The goal of the initiative is to develop and implement a comprehensive food safety education campaign aimed at increasing consumer understanding of foodborne illness and what can be done to decrease its occurrence.

In April 1998, the partnership continued its efforts to combat foodborne illness and extended its activities by implementing education programs aimed at school children. This resulted in the launching of the Fight BAC!™ Campaign, a unique food-safety program for children from kindergarten to grade 3. The materials, which can be used by teachers, group leaders, nurses and others, illustrate the key steps in the safe handling of food, and they include take-home messages to educate parents. This information, along with other food-safety information such as recalls, health hazard alerts and fact sheets, is available on the CFIA Web site (**http://www.inspection.gc.ca**).

2b.4 EMPHASIZING PREVENTIVE APPROACHES AND SUSTAINABLE DEVELOPMENT

In *Science and Technology for the New Century: A Federal Strategy*, specific areas were identified where S&T resources need to be focused. These areas, referred to as operating principles, include preventive approaches and sustainable development. S&T is critical for both areas. For preventive approaches, S&T is required to evaluate the extent of any potential and actual risk, a crucial requirement for sound decision making. For sustainable development, S&T helps to facilitate the long-term environmental and social benefits associated with sustainable growth.

The role of S&T for both preventive measures and sustainable development has become apparent during the past five years. Emphasizing preventive measures has translated into the use of the precautionary approach and the precautionary principle (applied when there is scientific evidence of uncertain risks), and into focusing on risk management regimes. With respect to sustainable development, the application of S&T involves the protection and conservation of the environment, social development, and the provision of accurate information and tools for sound sustainable decisions. It also entails increased innovation, as exemplified by processes of eco-efficiency, to expand economic prosperity.

Preventive Approaches

Since the introduction of the strategy, there have been several federal initiatives that promote a preventive approach. One such initiative involves the Assistant Deputy Minister Working Group on the Precautionary Approach/Precautionary Principle, which has released a discussion document on a proposed principle-based framework to guide the application of the precautionary application and principle within federal risk management. The document, *A Federal Framework on the Application of the Precautionary Approach and the Precautionary Principle in Canada*, fulfills recommendations for the development of a framework providing guidance on the precautionary approach/principle, as outlined in the federal government's *The Framework for S&T Advice in Government Decision-Making* (see Section 2a.3).

In March 2000, the TBS tabled the government's new Integrated Risk Management Framework, entitled *Results for Canadians*. This framework is a

Improving the Health of Aboriginal Peoples

Since 1999, Health Canada has invested significantly in First Nations and Inuit community programs, focusing on prevention, including the Aboriginal Diabetes Initiative, HIV/AIDS Initiative, the Fetal Alcohol Syndrome/Fetal Alcohol Effects Iniative, and the National Native Alcohol and Drug Addictions Program.

practical guide to assist public service employees in their decision making. Specifically, it aims to:

- provide guidance to advance the use of a more corporate and systematic approach to risk management;
- contribute to building a risk-smart work force and environment that allows for innovation and responsible risk-taking while ensuring legitimate precautions are taken to protect the public interest;
- maintain public trust and ensure due diligence; and
- propose a set of risk management practices that departments can adopt (or adapt) to their specific circumstances and mandate.

The Integrated Risk Management Framework also recommends the development of a framework pertaining to the application of the precautionary approach and principle. This proposal is fulfilled by the Federal Framework on the Application of the Precautionary Approach and the Precautionary Principle in Canada.

Further promoting preventive approaches, the Canadian Centre for Management Development (CCMD) this year released the *CCMD Roundtable on Risk Management*, a report outlining research undertaken by the centre in consultation with risk managers. The work of two groups has been especially relevant for the CCMD Roundtable:

- the Privy Council Office-initiated Working Group of Assistant Deputy Managers on Risk Management and their report, *Risk Management for Canada and Canadians: Report of the ADM Working Group on Risk Management*, and
- the TBS work (noted above), the Integrated Risk Management Framework.

Recognizing that effective risk management — the ability to make good decisions about policies, programs and services in an environment of uncertainty — is critical for the public service, the *CCMD Roundtable on Risk Management* aims to provide a foundation for learning strategies and a curriculum for public sector risk management.

Sustainable Development

Over the past five years, there has been progress on several fronts to integrate the sustainable development approach into the activities of all federal departments and agencies. Activities have been implemented horizontally (across government) and on an individual-department basis. In the latter cases, activities also have been guided by the Commissioner of the Environment and Sustainable Development.

The government can be an important source of knowledge. When applied to policy and regulations, this knowledge can have significant benefits both for

The Canadian Lightweight Materials Research Initiative (CLiMRI)

CLiMRI *is a government-industry partnership initiated in 1999 with the primary goal to reduce greenhouse gas emissions by reducing vehicle weight. As a rule of thumb, every kilogram (kg) of weight reduction will result in 17 to 20 fewer kg of carbon dioxide emissions over the lifetime of a vehicle. CLiMRI is led by an industry steering committee, supported by a government secretariat. Its secondary goal is to improve the competitive position of Canadian companies involved in vehicle manufacturing. A key strength of CLiMRI is its ability to stimulate working partnerships along the entire production chain, thereby greatly improving the chance of a successful technology transfer. NRCan, the NRC and five universities perform the research, supplemented by the work of private sector R&D. Additional information regarding CLiMRI is available on-line (**http://climri.nrcan.gc.ca**).*

economic growth and an improved quality of life. Indeed, well-designed, scientifically sound regulatory systems can increase the international competitiveness of Canadian products by ensuring high quality and establishing a strong international reputation. For example, an independent case study done to assess the socio-economic impacts of EC's research supporting Canada's pulp and paper regulations concluded that, for an investment of about $13 million over nine years in federal research on the pulping process, the impact on Canada's GDP, as a best estimate, was about $546 million. EC's research broke new ground and helped to protect Canada's access to foreign markets. Also, if the department had regulated on the basis of existing scientific knowledge (mainly from Swedish research), industry would have needlessly incurred higher costs to comply with an inappropriate regulation.

Originally developed for military purposes, Canadian expertise in high-resolution satellite imagery is finding a range of new applications in resource management, such as monitoring environmental impacts, forest fires, geological hazards and state-of-the-art natural-disaster response. Under the program Earth Observation for Sustainable Development (EOSD), NRCan and the Canadian Space Agency have initiated a ten-year project in cooperation with the provinces and territories to use space technology, including LANDSAT and RADARSAT satellites, in developing a dramatically new approach to monitoring sustainable forest development indicators, including forest cover, composition and functioning. EOSD will support Canada's domestic information needs as well as international commitments, and will form a part of a new national forest inventory where information and data on Canada's forest ecosystems will be widely available via integrated, intelligent information systems.

A specific project undertaken by the five natural resources departments is the 5NR Nutrients Science Assessment, which commenced in 1997. This collaborative evaluation involved a comprehensive assessment of the extent to which nutrients derived from human activity may be impairing Canadian ecosystems and affecting the quality of life and health of Canadians. The findings of the 5NR Nutrients Science Assessment were released in the summer of 2000 and confirmed that anthropogenic nutrients are causing problems in certain Canadian ecosystems and affecting quality of life for many Canadians.

CIDA and NRCan are working in partnership with less-developed countries to

help them achieve sustainable development of their mineral resources by sharing Canadian technical expertise in environmental management practices and in reducing high CO_2 emissions associated with the production of concrete. Under a multi-million-dollar project, NRCan's internationally known Concrete Group is transferring technology pioneered by NRCan that uses fly-ash, an industrial waste product that normally goes to landfill, in manufacturing concrete. For every ton of high volume, fly-ash concrete produced, a one-ton reduction in CO_2 is realized. Other projects are aimed at opening doors for Canadian contractors and services in environmentally sound mining, while helping less-developed countries realize the economic benefits of new mineral development. Capacity-building projects in environmental mining practices are presently under way in Brazil, Guyana and Zambia.

Individual departments are implementing operative principles of sustainable development. Departmental initiatives to provide information and tools to make decisions to facilitate sustainable development are an important aspect of the use of S&T. Statistics Canada has added a system of environmental and resource accounts to the current system of National Accounts for impact analysis of the interplay between the economy and the environment.

The Commissioner for the Environment and Sustainable Development has assisted federal efforts to protect the environment and foster sustainable development by providing objective, independent analysis and recommendations. All departments and agencies were mandated to prepare Sustainable Development Strategies, which are monitored by the Commissioner to evaluate the extent to which departments and agencies have met the objectives and implemented the action plans set out in their strategies. The second generation of Sustainable Development Strategies, 2000–2003, offers examples of the utilization of S&T in sustainable development. Industry Canada aims to meet objectives outlined in its strategy by enhancing the capacity of Canadians, industries and firms to develop and use eco-efficient practices, tools, technologies and products that contribute to increased productivity and environmental performance. Furthermore, AAFC is focusing on increasing productivity and fostering sustainable agriculture through innovations generated from the life-sciences.

Renewable Energy for Remote Communities

In Canada, there are over 300 remote communities that are not connected to central electricity grids or natural gas networks. These communities are characterized by a high dependence on imported oil and very high energy costs, often coupled with a lack of local technical expertise. However, federal research support has led to the development of renewable energy technologies (RETs) that offer cost-effective options for off-grid green power generation and space heating, with added environmental advantages. NRCan has established new initiatives to provide technical training and certification programs to increase local expertise in the use of RETs, as well as market development and demonstration activities to increase awareness of economical applications of RETs and energy efficiency alternatives in Canada's remote communities.

2b.5 POSITIONING CANADA COMPETITIVELY WITHIN EMERGING INTERNATIONAL REGULATORY STANDARDS AND INTELLECTUAL PROPERTY REGIMES

As an open trading nation with a small domestic market, Canada has a vital interest in ensuring that its domestic regulatory practices, designed to protect citizens and the environment, do not inadvertently become barriers to investment and exports. The federal regulatory policy is highly cognizant of Canada's international obligations, stating at the outset, "When developing or changing regulations, federal regulatory authorities must ensure that regulatory officials are aware of and adhere to obligations set out in international and intergovernmental agreements and accords." Also, it is critical that Canada participate fully and occasionally lead in international fora and networks that develop global trade regulations and standards. Canada must ensure a gradual convergence between the norms for its own goods and services and those of other trading partners, and the diminution of restrictive trade practices. In recent years, the accelerating pace of international activity relating to standards and regulations has provided for many such opportunities.

Federal S&T activities are essential inputs to these international negotiations, as they provide a technical underpinning to the Canadian positions. A few highlights are given in the following text to indicate the concerted efforts that Canada has made in this area.

Canada is actively participating in both NAFTA and the World Trade Organization (WTO), with respect to technical barriers to trade and sanitary and phyto-sanitary measures. The WTO Agreement on Technical Barriers to Trade is the main international instrument and source of expertise for providing guidance to governments in the crafting of regulations that will safeguard their citizens and environment, while not discriminating against traded products more than is necessary to accomplish these legitimate objectives. The Technical Barriers to

Promoting Canadian Interests in Telecommunications Standards Development

Canada is proactively involved in the International Telecommunications Union (ITU) and the Inter-American Telecommunications Commission (CITEL) in the development of regional and global standards for radiocommunication systems. Given the rapid pace of wireless technology development and the fundamental requirement to ensure there is sufficient spectrum available to support new wireless products and services, it is essential that Canada promote and defend the Canadian interests of wireless service providers and manufacturers in the context of international standards and regulatory bodies. Changes in international standards and regulations can have significant implications for this industry. As Canada prepares for critical meetings such as the World Radiocommunication Conferences (WRCs), complex technical issues need to be resolved, and this work forms the basis for many of the decisions taken at WRCs. The Spectrum Engineering Branch of Industry Canada and the Communications Research Centre (CRC) have worked closely on a number of these issues. For example, CRC has recently completed a measurement study that addresses the impact of wireless access systems on Earth Observation satellites in the 5 GHz bands. Also, CRC is involved in the development of new domestic standards through their participation in the Radio Advisory Board of Canada. In sum, participation and leadership in these international science-based activities for standards development and conformity assessment are increasingly important to Canada, as they contribute to the competitiveness of Canadian products by increasing their acceptance in world markets.

A Role for Federal S&T in International Trade

The Canadian Food Inspection Agency (CFIA) and Natural Resources Canada (NRCan) are collaborating on increased research and monitoring activities to respond to an unpredictable downside to increased trade flows, particularly with new trading partners in Asia and the southern hemisphere — the potential introduction to Canada of "exotic" forest pests in wooden packaging materials sent with the shipping containers. Many of these containers are transported inland. These pests can include micro-organisms, such as bacteria and fungi, wood boring insects and defoliators, and predators of domestic species. NRCan is providing scientific and technical support to the CFIA to assist the latter's efforts on a number of fronts, including the development of an international phyto-sanitary standard with the International Plant Protection Committee, designed to minimize the risk of exotic pests being transported via solid-wood-packing materials.

Trade covers the regulation of all industrial goods not specifically included in the WTO agreement on the application of sanitary and phyto-sanitary measures. Canada's aim in these activities is to ensure that foreign regulations be science-based and that they do not arbitrarily discriminate against imports on the basis of non-science factors.

One example concerns metals and minerals. Canada has been concerned that the European Union (EU), particularly its member state France, has taken actions to ban asbestos without having done a proper risk assessment, such as has been done in Canada using a science-based approach. The analysis of the risks associated with using asbestos in certain building products, compared with the use of substitute fibres, has not been done. Canada remains committed to the development of an international trade policy approach within the context of the WTO Agreement on Technical Barriers to Trade, based on the concept of the safe use of products and the need to manage risk.

The environment is an area where there have been extensive attempts to harmonize and cooperate internationally. Canada is an active participant, and often a leader, in the broad range of international science-based agreements that are designed to prevent harm to the global environment. These agreements cover a wide array of interests, including the preservation of the stratospheric ozone layer, the protection of endangered species, the maintenance of fish stocks, the conservation of biodiversity and its companion protocol on biosafety. All of these activities are underpinned by years of accumulated scientific research and results that provide information on the status of natural phenomena, the causes of change and indications of remedial action when called for. Two more recent, and as yet unratified, agreements affecting the environment are of high interest to Canada. They include the Kyoto Protocol on climate change, designed to manage greenhouse gas emissions, and the treaty directed toward a ban of certain persistent organic pollutants. Collaboration for environmental regulation may take place regionally (e.g. for the Great Lakes) or internationally.

What these efforts show is that states recognize that it is no longer possible, or even desirable, to think of regulation as a purely domestic matter. Disagreements and disputes are necessarily part of the international trade area, again pointing to the critical need to be involved in the design and development of trade rules and regulations, and to rely on a neutral,

high-quality science-based regulatory regime for the available information on risks and benefits.

A long history of international cooperation is a feature of standards development and related conformity assessment activity, and it too is an area where Canadian efforts have been intensifying. Canada has long been a member of major bodies such as the International Organization for Standardization (ISO) and its companion organization, the International Electrotechnical Commission. It also participates in a group of inter-governmental standards organizations concerned with food and related issues, including the Codex Alimentarius Commission, the International Organization for Epizootics, and the International Plant Protection Convention. All of these organizations and others help establish international norms for ensuring that products are safe to the consumer, while simultaneously facilitating trade through the establishment of a consistent basis for the production of products. Canada has been a leader in several standards development areas, such as the ISO's production of its 14 000 series of environmental management standards, which assist industry to take environmental considerations into account in the design of both products and processes.

Canada, through the Standards Council of Canada, is becoming more active in a variety of international and regional efforts to simplify the accreditation of testing laboratories and conformity assessment bodies. These activities should, over time, make the flow of goods among countries easier by reducing the number of times a product has to seek approval. They should also make these goods cheaper by reducing the amount of testing required for each individual market. Relevant fora include the International Accreditation Forum, the International Laboratory Accreditation Co-operation, the Pacific Accreditation Co-operation and others.

Science is critical to these trade-related activities in global and regional fora. For example, Canada, through the NRC, actively participates in establishing global norms for the field of metrology and the development of measurement standards. These global initiatives fall under the auspices of the Comité International des Poids et Mesures, and are spearheaded by a Mutual Recognition Arrangement (MRA) signed by the national metrology institutes of 48 nations. The MRA provides an opportunity for Canada to undertake the substantial work required to streamline the process of multilateral recognition of measurement standards by current and potential trading partners. The regional fora fall under various trade-related agreements, including the North American Metrology Cooperation under NAFTA, the Inter-American Metrology System supporting the Free

Resolving Measurement-Based Trade Disputes

Through its association with the development of global measurement standards, the National Research Council (NRC) has been involved in the resolution of measurement-related trade disputes. One example is the resolution of a disagreement between Canada and Europe, concerning pulp-brightness-measurement techniques. As the world's largest exporter of pulp, the discrepancy could have had severe consequences for one of Canada's largest industries. In the end, though, the agreement reached on measurement techniques saved the Canadian paper industry some $100 million per year in extra bleaching costs.

Trade Area of the Americas (FTAA), and the Asia Pacific Metrology Program under APEC.

MRAs, in fact, represent another avenue of trade relations that Canada pursues. MRAs are normally government-to-government agreements or arrangements that formally accept, as equivalent to their own, the conformity assessment activity (much of it based on scientific research and testing) performed in the exporting country that is undertaken to conform to the importing country's regulatory requirements. At present, Canada has only a handful of MRAs, including ones with the European Union, Switzerland, Iceland, Liechtenstein and Norway.[4] These MRAs cover several sectors, for example, telecommunications terminal equipment, electromagnetism, electrical safety, medical devices, good manufacturing practice in pharmaceuticals, and, with the exception of Switzerland, recreational craft. However, experience to date indicates that devising these multi-sectoral MRAs is a resource-intensive and complicated exercise, requiring coordination across jurisdictional boundaries within Canada, and then an extensive confidence-building effort between the relevant regulatory authorities in each of the countries involved. MRAs, therefore, are not a solution for all cases, and it may be that accreditation cooperation may prove more cost-effective. Efforts continue to determine the best approaches for different contexts.

In its ongoing effort to attain a national regulatory system of the highest international quality, Canada has been participating in the OECD program on regulatory reform. It has requested a review for the purposes of both demonstrating a solid performance in this area, and benefiting from any constructive criticism — anticipated in 2002 — that can help to improve systems or close gaps. Canada is confident about attaining a good report card in this area.

Intellectual property is another key element for strengthening Canadian competitiveness and innovation capacity. Intellectual property regimes provide the framework for a brisk and orderly exchange of ideas and designs, a flow that is as important to our economy as that of currency, goods and services. Intellectual property rights represent a balance between the need to provide incentives to spur innovation and the benefits derived by society to have maximum access to new creations. These are intangible rights granted by states to private parties to encourage creations of the mind such as inventions, artistic and literary works, and marks and symbols. These rights prevent misappropriation

4. Iceland, Liechtenstein and Norway are the three remaining members of the European Free Trade Area.

Federal Science to Resolve Trade Disputes

Science plays an important role in managing Canada's trade relationship with other nations and in the context of international, trade-related fora. For example, the devising of simple and quick tests by Agriculture and Agri-food Canada (AAFC) to identify hormone or antibiotic residues or to distinguish new foods from traditional foods helps to ensure compliance with new science-based regulations and to open new marketing opportunities for Canadian exports. Through reliance on its comprehensive culture and herbarium collections, AAFC researchers rapidly developed an effective soil sampling process that stymied the spread of potato wart in Prince Edward Island and allowed the Canadian Food Inspection Agency to demonstrate to our trading partners Canada's success at controlling and eradicating agricultural pests.

by others and allow creators a right of ownership and the possibility of obtaining a return on their investments through temporary monopolies (e.g. patents, copyright, industrial designs). The records and documents that protect intellectual property owners' rights contain valuable information and much of it is available to the public, thus contributing to the flow of ideas and encouraging the generation of new ones.

The Government of Canada is actively involved in a number of bilateral, regional and international fora to promote intellectual property and to ensure Canada's international competitiveness. The World Intellectual Property Organization (WIPO) continues to be an active forum for developing new intellectual property rules. The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights and NAFTA incorporated some of the well-established intellectual property obligations in WIPO conventions, brought them into a trade context, and added specific commitments on enforcement and made those obligations subject to binding dispute settlement. At the regional level, the Government of Canada is actively involved in the FTAA negotiations, as well as with organizations such as the OECD and APEC. Canada has been working diligently in international fora to build a fair, efficient and competitive marketplace for Canadians. The ongoing work includes consideration of the interplay of new technologies and issues such as those relating to e-commerce, the Internet (e.g. domain names), biotechnology (e.g. patenting of higher life forms) and traditional knowledge.

2b.6 BUILDING INFORMATION NETWORKS: THE INFRASTRUCTURE OF THE KNOWLEDGE ECONOMY

Advances in information and communication technologies provide opportunities for Canada to develop an integrated world-class system for the creation, sharing and dissemination of scientific, technical and medical (STM) information to support the Canadian innovation system. A national STM electronic information management and dissemination system, based on the principles of easy and equitable access, interoperability, and assured future availability, can be a valuable tool to enhance Canada's R&D capabilities.

Such a system integrates the best practices of knowledge and information management. Information resources, systems and expertise that reside across the country in federal and provincial government departments, universities, hospitals, scientific societies and publishers could be linked through an integrated, interoperative system that delivers cost-effective, user-specific, easy access for researchers and innovators in the industrial, academic, health and public sectors. Components include databases, catalogues, electronic publications, information services, search tools, document delivery, access to expertise and collaborative software, among other features.

In the U.S., progress is being made in this direction. The Department of Commerce has developed a Web-accessible database of government resources (**http://scitechresources.gov**). The database provides valuable links to government expertise, services, laboratories, information centres and other important resources of interest to scientists, engineers and technologists. This Web site

Canadian Geospatial Data Infrastructure

*GeoConnections is a national partnership of Canadian companies, governments and academia to make geographic information accessible to Canadians on the Internet. Led by NRCan, the objectives are to expand access to geospatial information, establish a common national data framework, called the Canadian Geospatial Data Infrastructure (CGDI), develop common international geospatial standards and provide a forum to advertise and increase Canadian capacity to exploit growing international markets for spatial data products, tools and services. The Discovery Portal supports a broad range of both suppliers and users of geospatial information and services. For further information, visit the GeoConnections Web site (**http://www.geoconnections.org**).*

ensures that these government resources are easily accessible.

A nation's international competitiveness depends on its ability to innovate and rapidly exploit S&T. The driver for rapid innovation and bring-to-market activity is timely access to relevant information. The nation with the ability to manage information in the context of a national system is more likely to be competitive in the global market.

Ready information access and exchange will enhance communication among researchers and support the collaborative, interdisciplinary R&D that is essential to the country's success. Similarly, leaders and policy makers at all levels will have the tools they need to support effective decision making.

Across the federal SBDAs, various initiatives are in place to facilitate the development and sharing of STM information resources, systems, networks and expertise. Some examples follow.

As the nation's science library and largest science publisher, CISTI is a key component of Canada's STM information infrastructure. Through CISTI's Web-based catalogue and state-of-the-art document delivery system, Canadians have access to the information resources available in CISTI's collection and in STM collections around the world. Consortia arrangements ensure that Canadian universities have preferential service delivery, allowing them to rely on CISTI to supplement their own STM information resources. In 2000–2001, CISTI processed over one million orders for documents. Approximately 325 000 orders were received from the Canadian academic sector and 140 000 from the industrial sector. These numbers continue to grow, indicating the value of this service to Canada.

As an important building block for Canada's information infrastructure, CISTI has implemented the "e-Infostructure." The objectives of the e-Infostructure are to provide an electronic infrastructure that has the capacity to contain all electronically published STM information generated worldwide and to ensure long-term Canadian access. CISTI's vision is to extend access to these resources as they are developed to the Canadian research community. As a step in this direction, the free distribution of the NRC Research Press electronic journals to Canadians is provided through the e-Infostructure.

2b.7 EXTENDING CANADA'S S&T LINKAGES INTERNATIONALLY

One of the key factors impacting the performance of S&T in Canada is the highly competitive international domain. Increasingly, it is the world beyond our boundaries that is the greatest source of

Collaborative Research on International S&T

Researchers at NRC's Institute for Information Technology (IIT) were invited to join the international Civilian American and European Surface Anthropometry Resource (CAESAR) project. This project, which digitizes measurements, generates information for the design and development requirements of the member companies, for cars, garments, safety equipment and other applications. CAESAR project members extract information from the anthropometric database using IIT's unique Cleopatra system.

NRCan Leads International Gas Hydrate Research Program

Natural gas hydrates represent an immense hydrocarbon resource underlying large portions of the world's arctic continental shelves. With the completion of scientific studies undertaken as part of the 1998 Mallik 2L-38 gas hydrate research well program, a world research site was established for the study of Arctic natural gas hydrates in the Mackenzie Delta of northwestern Canada. Mallik 2002 is a $25-million international program. An international consortium involving some 100 scientists led by NRCan, with participation from Canadian industry, Japan, the U.S., Germany and India, has been formed to take part in this groundbreaking research — the first of its kind in the world. The program is investigating the production potential and economic viability of gas hydrates, and their role in climate change and as a geohazard. This project will position Canada at the forefront of gas hydrate research.

new ideas and emerging technologies. The U.S. Department of Defense is the largest single sponsor of technology development in the world, with an R&D and test and evaluation budget of roughly $US 40 billion. Similarly, European Union Research and Technology Development Framework programs represent investments of $Cdn 20 billion for four years. To tap into global knowledge, it is essential for Canada to deepen its involvement in international S&T partnerships.

The federal S&T community leverages its R&D investment with partner organizations and research colleagues in other countries through scientific exchanges, joint projects, technology alliances, information exchanges, networks, bilateral and multilateral arrangements, and international programs.

For example, the **Canadian Food Inspection Agency** is an active participant in the development of science-based sanitary and phyto-sanitary standards and regulations through organizations such as the Codex Alimentarius, the International Plant Protection Convention, and the Office international des épizooties.

The **Canadian Space Agency** (CSA) has obtained global recognition and established Canada as a reliable partner on the international space scene. Such recognition has enabled us to participate in various projects and joint programs with many other countries, including the U.S., France, Japan, Italy, as well as with the European Space Agency.

The **Meteorological Service of Canada** represents Canada in the Inter-American Institute for Global Change Research (IAI), an intergovernmental organization for the Americas dedicated to global change research and capacity building. The IAI serves as an avenue for bilateral work in this hemisphere and provides a potential avenue for linking some environmental science activities between NAFTA and potential NAFTA parties. Chile and Argentina, for example, are already members of IAI.

The Technical Cooperation Program (TTCP), between Australia, Canada,

Partnering Globally: The MUST 2000 Sensor Trial

A successful major initiative over the past year was the MUST 2000 trial (Multi-Sensor Trial), held at Cowley Beach in Queensland, Australia, in May 2000. More than 20 electro-optic, infrared and radar sensors were fielded in this trial. Sensors provided by Canada, Australia, the U.K. and the U.S. included four satellite systems, five airborne systems and a wide range of ground-based sensors. The extensive nature of this trial makes it unique, and the results will enable these nations to assess the value of multiple sensors for detection and classifying a broad range of targets, including military vehicles, minefields and the release of simulated chemical agents. The assets being brought to this trial are far beyond what is directly available to Canada, and they allow us to assess the value of multi-sensor data fusion for future acquisition programs. Because of its participation, Canada is able to leverage assets valued at many millions of dollars.

Studying Lake Trout Survival in the Great Lakes

DFO is leading a team of researchers from Canada and the U.S. to determine the contribution of egg and fry (larval stage) predation to the failure of lake trout recruitment in the Great Lakes. Recruitment refers to the addition of harvestable fish to a population through reproduction. This work is in addition to other collaborative work under way with Canadian and U.S. investigators to assess the effects of a thiamine deficiency on lake trout reproduction. Between 500 000 and 1 million lake trout are caught in the Canadian waters of the Great Lakes each year, ranking lake trout as one of the most prized species in the recreational fishery. The Great Lakes recreational fishery is worth an estimated $1 billion annually.

New Zealand, the U.K. and the U.S., is **Defence R&D Canada's** (DRDC's) primary vehicle for multi-national collaboration. TTCP fosters cooperation in the S&T needed for defence and encompasses basic research, exploratory development and demonstrations of advanced technology development in research groups ranging from Materials Technology, Sensors and Chemical, Biological and Radiological Defence.

Canadian firms are now being recognized as world leaders in geomatics and remote sensing, particularly in the areas of Web mapping and international standards. **NRCan's Canada Centre for Remote Sensing** has been a major force in the rapid evolution and international competitiveness of a new domestic industry made up of small but highly innovative firms. NRCan is working to consolidate Canada's position as a leader in geomatics, using various mechanisms such as memoranda of understanding with China and Iran, and the creation of a Geomatics Trade Post in Argentina.

While the majority of Canada's international scientific interactions are conducted on an informal scientist-to-scientist basis, there are several hundred S&T arrangements between Canada's SBDAs and organizations in other countries around the world. These linkages are used to open doors and build bridges for all Canadians. Moreover, Canada's SBDAs implement numerous international programs designed to promote Canadian science globally, foster solid linkages with our partner countries and expand our scientific resource base. Some examples include:

- the NATO Research and Technology Organization,
- the NRC collaborative agreements with the Centre national de la recherche scientifique in France, the British Council in the U.K., and the publicly funded organizations in Germany, and

- the NSERC MOU with the Royal Society in the U.K. to create the Canada-U.K. Millennium Research Awards.

These investments in S&T also attract and retain top-notch researchers in Canada by enhancing our research environment.

Approximately 40 percent of Canada's scientific collaboration is with the U.S., including the following examples:

- the Distributed Mission Training Technologies, a project funded under DRDC's $30-million Technology Demonstration Program, in collaboration with the U.S. under the Technology Research and Development Projects MOU;
- Canada's contribution to the International Space Station through the Mobile Servicing System, which includes Canadarm2; and
- the Banff International Research Station for mathematical discovery and innovation, which is a collaboration of the governments of Canada and Alberta and the U.S. National Science Foundation.

Global Investments with the University Community

Canada is collaborating with six other nations to build and operate two telescopes comprising the Gemini 8-meter Observatories, located in Hawaii and Chile. Funded by NRC, NSERC and the WESTAR consortium of universities, this large international science project will provide Canadian astronomers with unprecedented access to the study of star formation, distant galaxies and planets outside the solar system.

The Government of Canada's international linkages allow researchers in Canadian universities, business sectors and government laboratories to access much larger pools of expertise and leading-edge equipment and facilities than are available in Canada.

These linkages enhance the research and technology expertise of Canadian companies by affording cost-effective opportunities to validate the readiness of their technologies for new applications in the global marketplace. International collaborations in S&T are also excellent instruments to attract and retain top-notch researchers in Canada — something that will become increasingly important as the Canadian government moves to increase the country's R&D activity to move to fifth spot in global R&D expenditures by 2010.

The **Department of Foreign Affairs and International Trade** manages a network of S&T counsellors at missions in six OECD countries, as well as Trade Commissioner Service Officers in a number of Canadian missions around the world. These counsellors not only promote the awareness of Canadian scientific and technical excellence internationally, but also assist Canadian-based research institutions and firms in accessing advanced knowledge and technology worldwide, and support SMEs in their efforts to expand globally.

With approximately four percent of the world's scientific knowledge produced in Canada, there is room to extend our international linkages and strengthen our national innovation capacity. In the report of its Expert Panel on Canada's Role in International Science and Technology, *Reaching Out: Canada,*

International Science and Technology, and the Knowledge-based Economy, the Advisory Council on Science and Technology (ACST) recommended that Canada ensure an appropriate level of investment in S&T, strengthen its policy framework for involvement in international S&T and create an efficient mechanism for coordination within the federal government. The ACST report will likely continue to stimulate much needed discussion around how Canada could, and indeed should, strengthen its participation in international S&T opportunities. Also, it serves as a useful reference point for addressing the government's involvement in international programs.

2b.8 PROMOTING A STRONGER SCIENCE CULTURE

The S&T strategy indicated that fostering a strong science culture is everyone's business. A strong science culture must be the foundation for building the Canadian innovation system of the 21st century. Young Canadians in particular need to understand and see the benefits of learning science and engineering for their future careers and adult life.

Making full use of the Information Highway, departments and agencies developed action plans to reach out to the community, including young people in schools (and their teachers), universities and colleges. Promotional activities over the last five years have included the publication of promotional and scientific material, the dedication of specific facilities, and the establishment of scholarships and recognition programs.

Promoting science and its role in modern life and society was at the heart of the **Millennium Conferences on Creativity in the Arts and Sciences**. These were initiated by the NRC, the Canada Council for the Arts and the National Arts Centre of Canada. They grew to embrace most of the leading S&T organizations in Canada, as well as international partners. The series was a celebration of similarities between scientific research and artistic expression, and it promoted collaboration between the disciplines. The initiative, which began in 1998, introduced science to a variety of non-traditional audiences, notably students in arts, social sciences and humanities. Today, it continues to resonate in new projects and a popular report, *Renaissance II: Canadian Creativity and Innovation in the New Millennium*. In the same vein, NSERC and the Canada Council for the Arts have developed a joint initiative to cooperate in funding multi-disciplinary research involving arts and S&T, particularly in the area of new media.

A special dimension was added to the national astronomy education and science promotion landscape in 2001 when the NRC's Herzberg Institute of Astrophysics opened a multi-faceted visitor's centre next to its Dominion Astrophysical Observatory (DAO) near Victoria, B.C. Called **The Centre of the Universe**, the facility is unique because of its focus on the celebration of Canadian astronomy and its proximity to the historic DAO optical observatory. The centre will support other efforts to promote Canadian astronomy and achievements in all regions, and to collaborate with other agencies, universities and organizations.

With support from the Atlantic Canada Opportunities Agency (ACOA) and the Province of Nova Scotia, the **Discovery Centre**, an interactive science-education facility provides a hands-on learning

opportunity for youth. ACOA has also supported the involvement of senior students from Atlantic Canadian high schools in the Shad Valley Program, a national initiative whereby students attend S&T entrepreneurship camps at universities and experience a positive exposure to science curricula. Acadia University, the University of New Brunswick and Dalhousie University participate in this national initiative.

Supporting communities and regions in promoting science culture is a facet of federal activity across Canada. Western Economic Diversification Canada (WD) has provided support for the establishment of the **Edmonton Space and Sciences Centre**, now known as the **Odyssium** (**www.odyssium.com**). The centre attracts over 500 000 visitors each year, including over 140 000 students. The centre has played a major role in introducing the wonders of S&T to over six million people. New features include three additional learning centres and the Future Scientists' Lab. The Odyssium focuses on Alberta's special geographical features, as well as the environment, forensics and health. In Saskatchewan, WD and six other federal departments have provided funding to the Saskatchewan Indian Federated College (SIFC) through the new Aboriginal Science Fund initiative. It provided the SIFC with financial assistance geared to increasing the number of Aboriginal graduates qualified for S&T-oriented jobs in the public and private sectors. The SIFC will increase awareness of S&T careers, promote its own science programs among Aboriginal students across Canada, and develop a new science curriculum with promotional and educational materials for student recruitment.

The federal government has a key role in promoting and preserving Canada's natural heritage. Federal S&T activities are important in promoting a culture that understands and values the scientific underpinnings of the world around us. Parks Canada's science education program started in 1996. It is a public education program through which some parks provide basic park research and monitoring data to education ministries, local school boards and education publishers for use in basic subjects like English and mathematics. Also included is an orientation course for employees to learn why ecological integrity is the foundation for national park management, why it is everyone's business, and why they should spread the word to colleagues, visitors, friends and relatives. Parks Canada has introduced science-based material on its Web site and has produced three science report series. Provided that there are no conflicts with heritage protection, Parks Canada endeavours to provide logistical support and information to museums, publishers and the broadcast media, especially interviews and audiovisual material to the producers of television documentaries. In the same way, NSERC has implemented an active media relations program that has resulted in thousands of science stories appearing in Canadian newspapers and on radio and television. In an average month, NSERC-related newspaper articles reach almost four million readers.

Under the **Education and Youth Awareness Program**, the CSA produces information and learning-based materials, turnkey teaching packages and virtual presentations focusing on the science and mathematics of space. The

The National Atlas of Canada on the Web

*The National Atlas of Canada has been in existence for 100 years, used by students, teachers and researchers across the country. What is new is that the atlas is no longer a stand-alone paper product, but one of the very first interactive atlases in the world to be made available on the Web. It has become a major medium for the distribution and understanding of information on Canada's geography. Coordinated by NRCan, other federal partners include Statistics Canada, INAC, EC, DFO, IC and AAFC. The National Atlas of Canada now offers a variety of graphic and textual information options and combinations for all audiences and user groups. A novice user at home looking for information on climate change may wish to access already composed maps, with only a pan and zoom function. Sophisticated users may wish to perform complex searches, download data sets and combine various information to create their own unique maps. The atlas is available on-line (**http://atlas.gc.ca**).*

CSA also collaborates with the science centre community across the nation to bring extra-curricular space content and experiential learning opportunities to Canadians of all ages. In addition, the CSA has established a series of fellowships and scholarships including:

- the CSA Postgraduate Supplements in Space Technology,
- Scholarship Supplements in Space Science Program,
- participation in the Visiting Fellowship in Canadian Government Laboratories Program, and
- the Youth Space Awareness Grants and Contribution program to support not-for-profit organizations in their efforts to enhance space awareness among youth.

The **Canadian Museum of Nature** (CMN) has a number of programs that fulfill its public outreach mandate and bring alive the study of nature, wildlife and biodiversity for Canadians. At the public exhibitions site in downtown Ottawa, the CMN's education staff and volunteers offer hands-on interpretive programs, curriculum-based workshops, and education programs to visiting school groups and families. For those unable to visit the museum in person, travelling exhibitions produced by the CMN provide supplementary educational information to other museums and other learning institutions across Canada. The museum's science experts answer over 5000 queries each year from students, teachers and the general public. These experts emerge from their labs and fieldwork to showcase their work for the public at the annual "Meet our Scientists" weekend. The CMN hosts a public lecture series, in partnership with other organizations, that tackles environmental and conservation issues. And, to encourage engaging and accurate reporting of natural science issues, the CMN sponsors a national, magazine science-writing award through the Canadian Science Writers' Association.

Celebrating scientific discoveries and the role that they play in society is important to attracting new, bright minds into these fields. NSERC's **Michael Smith Awards for Science Promotion**, recognize individuals and groups for their outstanding contributions to the promotion of science. Through NSERC's Students Promoting Awareness of Research Knowledge (SPARK) program, youth are involved first-hand in writing the stories that promote research news to the public. Launched as a pilot project in

1999, SPARK now involves students from 17 universities. PromoScience, a program of grants to not-for-profit organizations helps Canadian youth learn about opportunities in science and engineering. Motivate Canada, one of over 60 organizations awarded funding through PromoScience, develops innovative didactic products such as an electromechanical robot that teaches young people the practical side of mathematics, engineering and physics.

On-line promotion has become a very powerful tool for the Government of Canada. **SchoolNet's Education Resources** Web site, designed for teachers, students and parents, is one of the world's largest collections of on-line educational resources. Canada's SchoolNet is a collaborative initiative led by Industry Canada, in partnership with provincial and territorial governments, the education community and the private sector. Its work is guided by the SchoolNet National Advisory Board, which comprises members of the provincial and territorial ministries of education, professional associations and the volunteer sector. The program is a part of Connecting Canadians, the government's strategy to keep Canada among the leading nations in connecting its citizens to the Internet. SchoolNet carries out many initiatives to encourage the use of information technologies in the classroom. Some of these initiatives are SchoolNet GrassRoots, SchoolNet's Network of Innovative Schools, First Nation's SchoolNet, LibraryNet and SchoolNet's Youth Employment Initiative.

Environment Canada's on-line newsmagazine ***EnviroZine*** covers a wide range of current environmental issues of interest to Canadians. It includes tools and ideas for individuals and community groups working to improve the environment. *The Inside Track* is aimed at the media and provides the scoop on the latest developments in environmental S&T. "Planet Update" is a 60-second radio feature produced by Environment Canada and distributed to radio stations across Canada. Ideally suited for the Web medium, it is a useful value-added application. *Science and the Environment Bulletin* is a bimonthly print and on-line publication, explaining Environment Canada's S&T research to Canadians. The bulletin highlights findings, research and data, and is presented in a topical manner, fact-driven, with broad appeal. *Science and Environment Bulletin On-line* is continually upgraded to extend its reach and add value to the subject matter through exclusive material and links to other resources.

FEDERAL INVESTMENTS IN S&T: STATISTICAL INDICATORS

Note: Many of the figures in Chapter 3 refer to the period 1995 to 2000. This is due to the fact that many statistics are more appropriately discussed as changes in constant-dollar (inflation-adjusted or "real" expenditure) amounts. GDP for the year 2001 is not yet calculated and, therefore, numbers have not been calculated in constant-dollar terms for 2001. Any figures for the year 2001 that have already been published refer to budgets and anticipated expenditures, not actual expenditures. The annotation [e] or (e) in some charts denotes these estimated data. Similarly, [r] or (r) denotes revised data and [p] or (p) denotes preliminary data.

3.1 INTRODUCTION

S&T includes two main activities:

- scientific research and experimental development (R&D), and
- related scientific activities (RSAs) such as data collection, information services, and operation and policy studies.

In 2001, 63 percent of the federal government's S&T expenditures were allocated to R&D activities. The federal government contributes to national R&D objectives by:

- funding R&D through granting councils and private sector contracts,
- conducting R&D in its laboratories, and
- fostering a climate conducive to R&D by providing tax credits, grants and other support services.

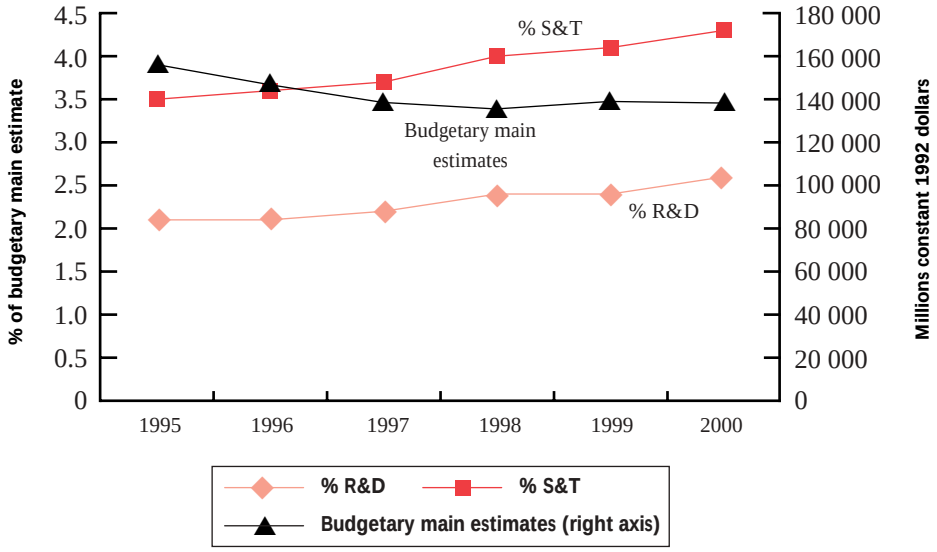
Research and Development *(R&D) Work performed to increase or enhance knowledge in order to create or improve applications of S&T.*

Related Scientific Activities *(RSAs) Activities to reinforce the findings of R&D by disseminating and applying S&T knowledge. Data collection, testing, scientific and technical information services, and museum services are examples of RSAs.*

3.2 EXPENDITURES ON S&T

Between 1995 and 2000, the federal government's budgetary main estimates (Figure 2) decreased overall from $156 billion to under $139 billion (constant 1992 dollars). Nevertheless, the proportion of the budget allocated to S&T activities increased from 3.5 percent to 4.3 percent.

Figure 2: Federal Budgetary Main Estimates, and Expenditures on S&T and R&D, 1995 to 2000



Source: Statistics Canada, 2001, *Federal government expenditures and personnel in the natural and social sciences, 1991–1992 to 2000–2001*[e]. Cat. No. 88F006-XIB, No. 8.

The government's $6.7 billion budget for S&T in 2000, translated into $5.9 billion 1992 dollars, is the highest level within the past ten years. For 2001, this level increased even further to $7.4 billion current[5] dollars.

Major changes in federal S&T spending for the period 1995–96 to 2000–2001 include the creation of the Canada Foundation for Innovation (CFI) and major increases in S&T funding for the NRC, Industry Canada, DFO and the CIHR (formerly the Medical Research Council). Statistics Canada's increase is due mostly to the additional activities associated with the 2001 census. The increase in Parks Canada reflects its creation as an agency from Canadian Heritage in 1998–99.

During the same period, several departments decreased their S&T spending. These include NRCan, Atomic Energy of Canada Limited, Environment Canada, AAFC and National Archives.

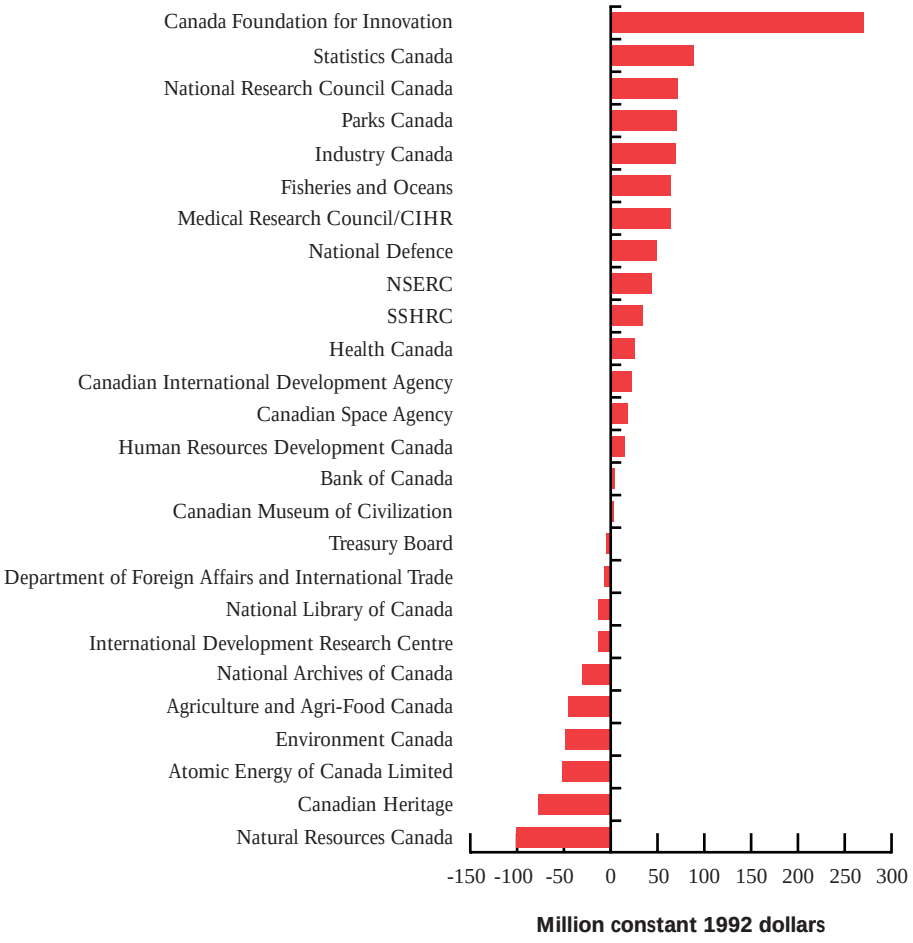
The CFI, which began in 1997–98, spent $305 million on S&T in 2000–2001. Figure 3 illustrates the major changes in federal S&T spending by department in constant dollars.

3.3 S&T PERSONNEL

The federal government engages scientists, engineers, technical staff and administrators to conduct, support, manage and administer research and development (R&D) and related scientific activities (RSAs).

5. At the time of writing, the value for 2001 could not be converted into constant dollars as GDP for the year 2001 had not been calculated.

Figure 3: Changes in Real S&T Expenditures, Major Departments and Agencies, 1995–96 to 2000–01[e]



Source: Statistics Canada, 2001, *Federal government expenditures and personnel in the natural and social sciences, 1991–1992 to 2000–2001[e]*. Cat. No. 88F006-XIB, No. 8.

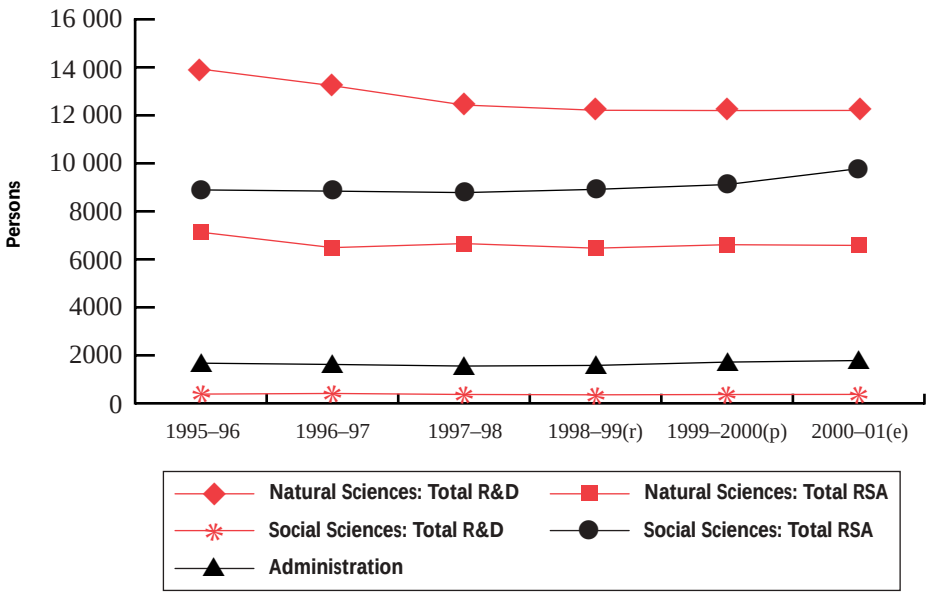
Real expenditures are actual amounts adjusted for inflation. The base year for these estimates is 1992; therefore, constant dollar values are expressed in terms of 1992 dollars. The adjustment is done by applying the GDP implicit price index.

Much like expenditures, S&T personnel are classified by the same two main activities, R&D and RSAs. They are also classified by their field of science (social sciences, natural sciences), by category (scientific and professional; technical; and administrative and support) and by department.

The number of personnel engaged in S&T activities in the federal government declined from about 32 000 in 1995–96 to under 31 000 in 2000–2001. This decrease is due almost entirely to losses in natural sciences R&D (Figure 4).

Of the nearly 1600 positions that were lost in the natural sciences R&D group,

Figure 4: Federal S&T Personnel by Field of Science and S&T/RSA, 1995–96 to 2000–01[e]



Source: Statistics Canada, 2001, *Federal government expenditures and personnel in the natural and social sciences, 1991–1992 to 2000–2001[e]*. Cat. No. 88F006-XIB, No. 8.

almost all were technical and administrative support (Figure 5). Over the same period, the number of scientific and professional staff remained fairly stable.

During this period, AECL's R&D personnel[6] dropped from 2015 in 1995–96 to 1145 in 2000–2001. AAFC's count of R&D personnel dropped 18 percent over the same period. As a result of program review in 1996, AAFC's research infrastructure was streamlined to a national network of 18 research centres. This consolidation focused scientific expertise in a smaller number of strategically important centres and reduced administrative overhead. In other departments, much of this drop is due to technological change, including computerization.

Chapter 4 provides a discussion of the age distribution of the federal government's S&T personnel.

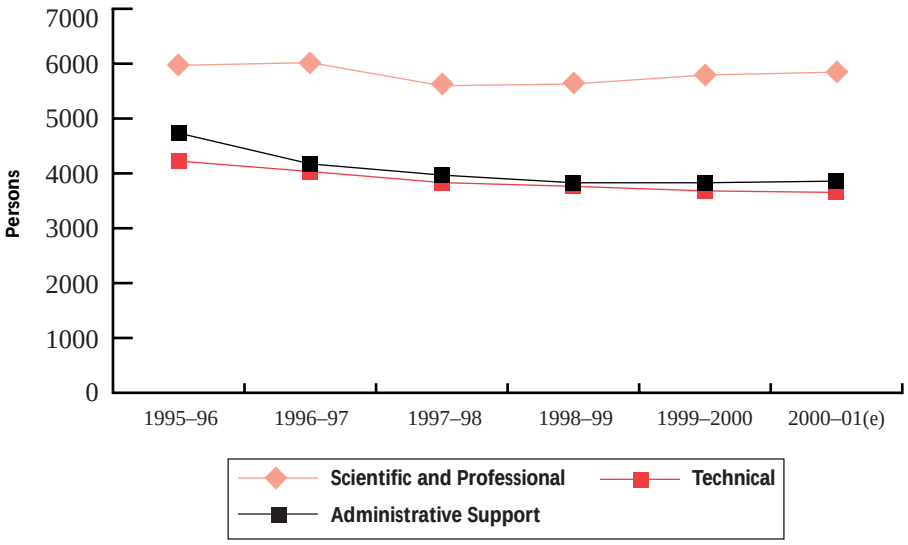
3.4 FUNDING R&D

To assess the role of federal S&T in Canada and the world, it is necessary to focus on the R&D portion. RSAs are not measured outside government in Canada, or in other countries. The standard international measure for R&D expenditures is the Gross Domestic Expenditures on Research and Development (GERD). GERD accounts for all expenditures on R&D conducted in Canada. For 2001, for example, GERD was estimated to reach $20.9 billion (Table 1).

Overall, the federal government's role in Canadian R&D has been declining since

6. These figures include personnel engaged in the administration of extramural R&D activities.

Figure 5: Federal R&D Personnel: Natural Sciences by Category, 1995–96 to 2000–01[e]



Source: Statistics Canada, 2001, *Federal government expenditures and personnel in the natural and social sciences, 1991–1992 to 2000–2001[e]*. Cat. No. 88F006-XIB, No. 8.

Table 1: Canada GERD, Total Sciences, 2001[e]

	Performing Sector						
Funding Sector	Federal Government	Provincial Government	Provincial Research Organizations	Business Enterprise	Higher Education	Private Non-Profit	Total
	(millions of dollars)						
Federal Government	1907	0	2	361	1431	31	3732
Provincial Government	2	181	42	70	635	22	952
Provincial Research Organizations	0	0	3	0	0	0	3
Business Enterprise	44	0	22	8078	603	23	8770
Higher Education	0	0	0	0	3609	0	3609
Private Non-Profit	0	0	0	0	462	103	565
Foreign	0	0	4	3147	75	14	3240
Total	1953	181	73	11 656	6815	193	20 871

Source: Statistics Canada, 2001, *Estimates of Canadian research and development expenditures (GERD), Canada, 1990 to 2001[e], and by province 1990 to 1999*. SIEID Working Paper Series, Cat. No. 88F0006XIE No. 14.

1995 when 20 percent of GERD was attributed to federal funding. The decline in the proportion of federal funding is the result of higher growth rates of business and foreign funding. In real terms, federal expenditures on R&D have actually increased (Figure 6).

In 2001, the federal government funded about 18 percent of R&D conducted in Canada. Of the total $3.7 billion, almost $2 billion was spent by the government in performing intramural R&D, mostly in its research laboratories. The other $1.7 billion was paid to higher education, business and private non-profit organizations to support extramural R&D activities performed by these groups.

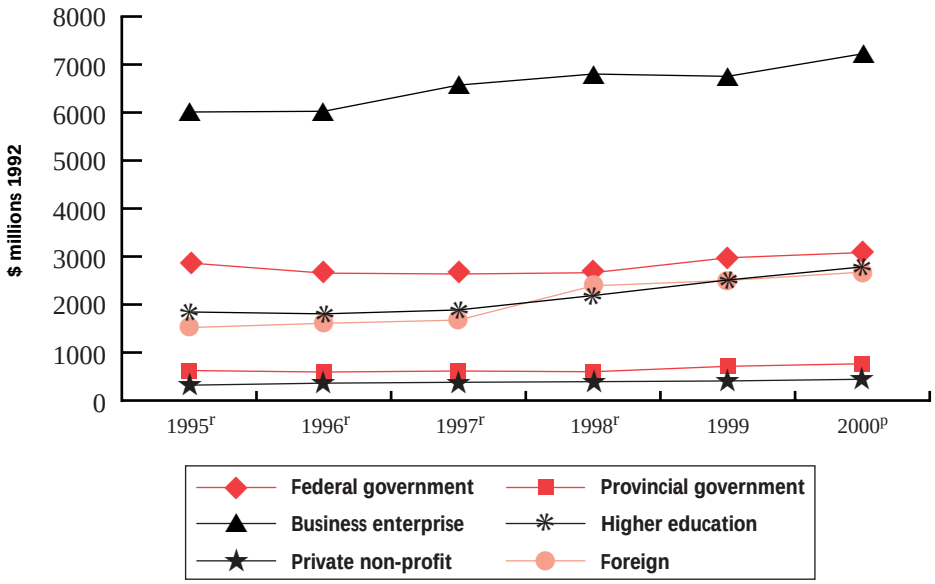
Between 1996 and 2001, the proportion of federal R&D funds spent on extramural activities increased from 37 percent to 48 percent (Figure 7).

3.5 PERFORMING R&D

Real expenditures on R&D performed by the federal government remained stable between 1995 and 2000, at between $1.6 and $1.7 billion. As a proportion of all R&D performed in Canada, this represents a decrease from 13 percent in 1996 to 9 percent in 2001 (Figure 8).

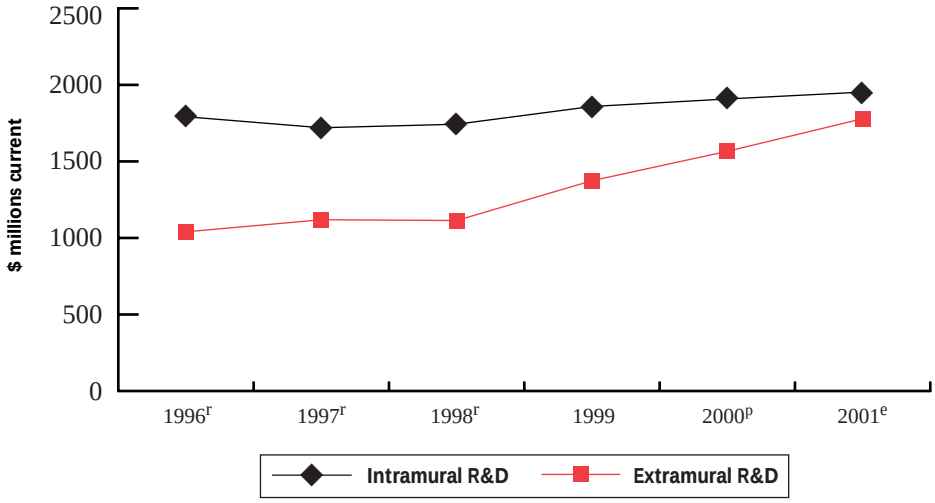
The nature of the R&D performed by the federal government has changed in emphasis over the past five years. Changes in real intramural R&D expenditures show an increased emphasis on public health, industrial production and technology, and non-oriented (or basic) research. Areas where there is now less emphasis include telecommunications and fishing. In the case of fishing, the decrease is largely due to a shift towards funding extramural R&D rather than conducting it in-house. Overall, R&D expenditures on fishing have remained stable.

Figure 6: Funding R&D in Canada, 1995–2000



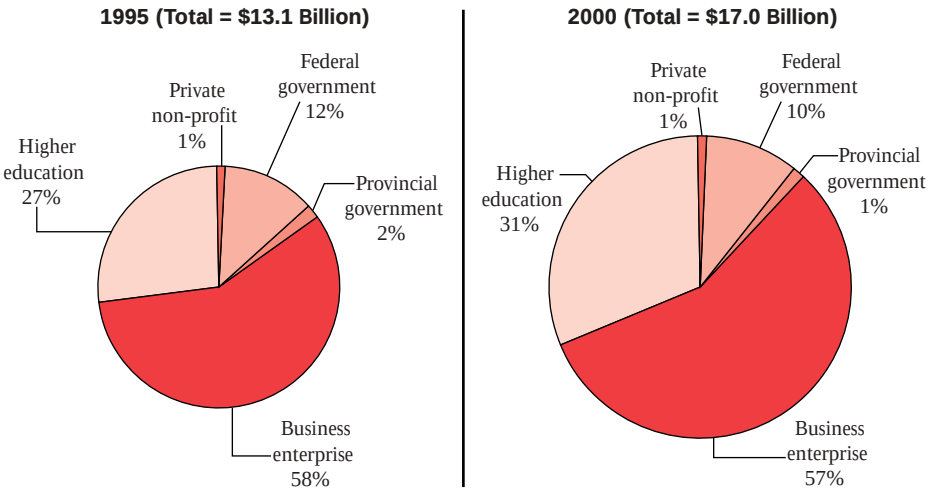
Source: Statistics Canada, 2001, *Estimates of Canadian research and development expenditures (GERD), Canada, 1990 to 2001[e], and by province, 1990 to 1999.* SIEID Working Paper Series, Cat. No. 88F0006XIE, No. 14.

Figure 7: Intramural/Extramural R&D by the Federal Government, 1996–2001



Source: Statistics Canada, 2001, *Estimates of Canadian research and development expenditures (GERD), Canada, 1990 to 2001e, and by province, 1990 to 1999.* SIEID Working Paper Series, Cat. No. 88F0006XIE, No. 14.

Figure 8: Performing R&D in Canada, 1995 and 2000



Source: Statistics Canada, 2001, *Estimates of Canadian research and development expenditures (GERD), Canada, 1990 to 2001e, and by province, 1990 to 1999*. SIEID Working Paper Series, Cat. No. 88F0006XIE, No. 14.

3.6 THE IMPACTS OF FEDERAL S&T

The impacts of federal S&T are diffuse and long-term. Much federal S&T is aimed at stewardship, regulation and risk management, which do not always have easily measurable statistical indicators.

Furthermore, the societal and economic benefits may be realized long after the actual activities have been completed. Benefits may also be attributed to sources outside the federal government. For example, a federal laboratory may develop a technology and grant a royalty-free licence to Canadian industry.

Supporting Innovation in the Private Sector

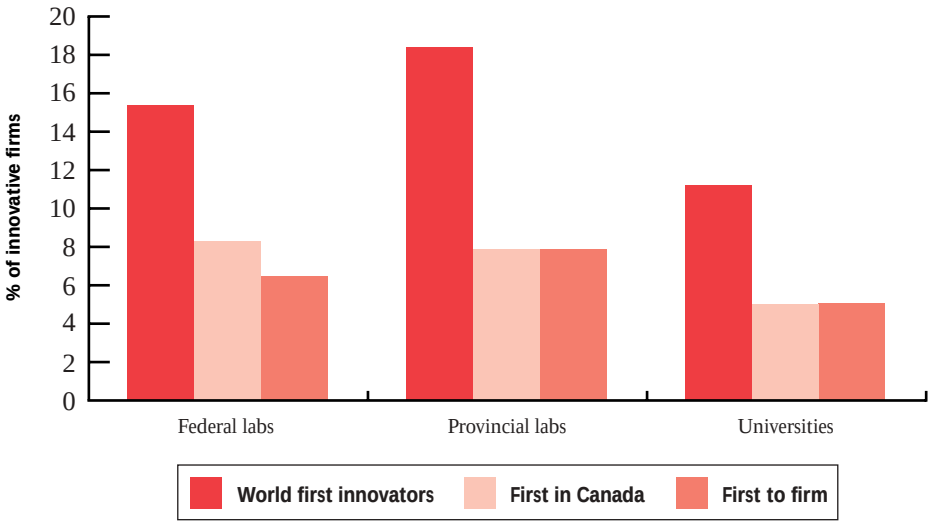
A major role for the federal government in S&T is technology transfer. Several programs focus on collaborating with university and industry, as well as providing scientific and technological information. One measure of the impacts of federal S&T is the importance that industry attributes to government collaboration and information.

Statistics Canada's *Survey of Innovation, 1999*, asked businesses the following questions:

- Have you introduced a new product to the market or a new production process within the past three years?
- What were the important sources of ideas for your innovation?
- With whom did you collaborate?

Innovations were further classified into "world firsts," "first to Canada" and "first to the firm." Firms with world first innovations were twice as likely to cite public institutions (universities, federal and provincial governments) as important sources of information than firms whose innovations fell into the other two categories (Figure 9).

Figure 9: Sources of Ideas for Innovation, 1999

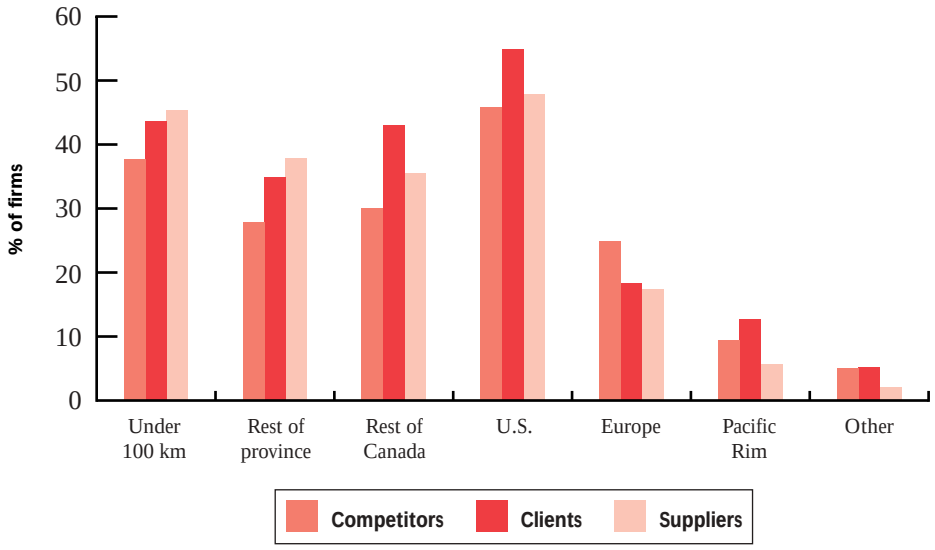


Source: Statistics Canada, Survey of Innovation, 1999, special tabulations.

Furthermore, although firms collaborate with private sector partners irrespective of distance within North America, public sector collaborators tend to be located near each other (Figures 10 and 11).[7] This can be attributed to the nature of the collaboration: business partners provide access to markets, whereas public sector

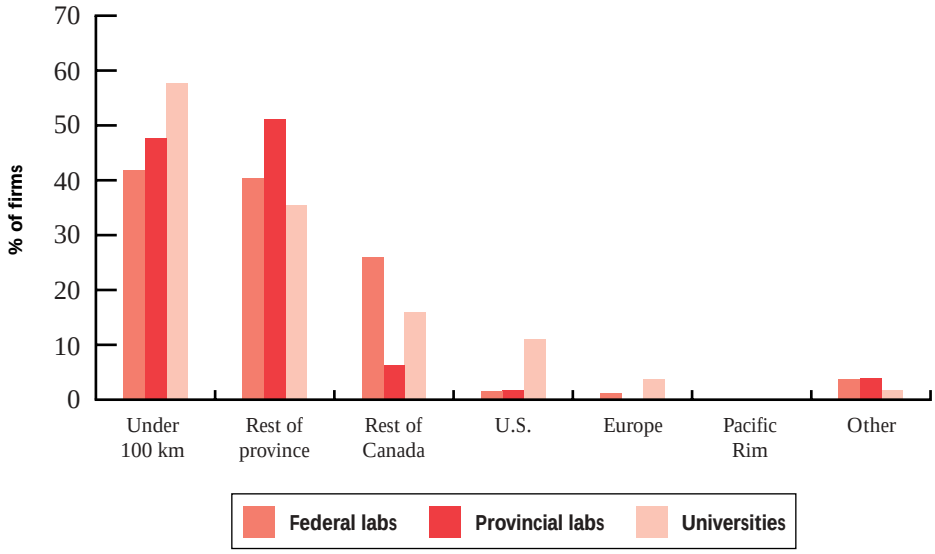
7. The percentages in figures 10 and 11 refer to the percentage of innovative firms that collaborate on R&D. Firms with multiple establishments were excluded from the distance tabulation.

Figure 10: Frequency of Collaboration with Private Institutions, 1999



Source: Statistics Canada, Survey of Innovation, 1999, special tabulations.

Figure 11: Frequency of Collaboration with Public Institutions, 1999



Source: Statistics Canada, Survey of Innovation, 1999, special tabulations.

partners provide expertise and R&D facilities.

Commercialization

Another measure of the impact of federal S&T is the degree to which the technologies developed are patented and licenced. Surveys of intellectual property management in federal science-based departments were conducted in 1998 and 1999 as annexes to the *Federal Science Expenditures and Personnel* survey. These surveys show that science-based departments hold 1946 patents. The federal government has a long history of breakthrough inventions, including:

- the CRC's "Fiber Bragg Gratings," considered among the world's top four advances in optical communications,
- AAFC's "Jumpstart" process that reduces the need for phosphorous fertilizer, and
- NRCan's BDM Process™ (Bio-Oil Diesel Mixture) that allows the use of bio-oils in conventional heat and power generation systems.

Royalties on licencing these patents increased from $6.9 million in 1998 to $12.0 million in 1999. However, the number of new inventions that were patented in that period declined. In 1998, 130 new patents were received, but in 1999 only 89 were recorded. Similarly, the number of new licences declined from 398 to 191, over the same period. The survey was conducted again in 2001, and results are expected to be available in mid-2002.

3.7 MEASURING FEDERAL S&T

Statistics Canada's survey of federal science expenditures and personnel is an essential tool that provides a detailed and consistent reporting structure. The results allow tracking of overall trends (such as total expenditures), and the details allow analysis of components of the trends (such as expenditures by department). It is an integral part of Statistics Canada's Information System for Science and Technology (see Section 2a.5) that links information on S&T, R&D, innovation and intellectual property. This information system provides the basis not only for analysis, but for reporting to national and international agencies that benchmark Canada's progress towards its policy goals.

LOOKING FORWARD

Science and Technology for the New Century set federal S&T on a new course. Its goals and operating principles have resulted in a federal science enterprise that is fundamentally different than that which was in place before. There is a strong focus on collaboration and partnership, and many new institutions have been created through which federal funds are flowing to other players in the innovation system. As the federal S&T strategy evolves, it will be important to understand and adapt to a changing context for federal S&T and a changing landscape for science in Canada and worldwide.

4.1 THE INCREASING IMPORTANCE OF SCIENCE

A recent analysis of questions, motions and debates in the British Parliament[8] points to the growing importance of science in parliamentary affairs. The proportion of the material examined that relates to S&T has increased about sixfold over the past decade, with biological and environmental sciences accounting for most of the growth. This change indicates the increasing role that scientific issues are playing in political decision making. Similar trends can be seen around the world and are reflected in moves by governments to ensure the excellence of both the science used in decision making and the processes that insert the science into those decisions.

This activity highlights not only the growing importance of science, but also the increasing sophistication and efficiency of interest groups in getting their issues on the agenda. It also reflects the growing importance of S&T for regulatory legislation, exemplified by issues such as the BSE ("mad cow disease") crisis and calls for "sound" science during the attempts to regulate GM (genetically modified) foods, as well as a recognition that the best medical practice is evidence-based.

Recent developments arising from government decisions in Canada and other countries, in the areas of natural resources management and public health and safety, have contributed to public concern regarding the ability of governments to effectively address science-based issues. Public interest groups and the media have used high-profile issues to increase pressure on the government

8. Ana Padilla and Ian Gibson, *Nature*, Vol. 403, 27 January 2000.

to make better use of impartial, transparent and excellent science through an open science advisory process.

In response to these concerns, *The Framework for S&T Advice in Government Decision-Making* was approved by Cabinet in April 2000. Cabinet recognized that the adoption of the framework would present many challenges. Departments would need to establish new procedures in a number of areas, including how and where science advice is sought, peer review, consultations with advisors and the public, review of science-based decisions, and the evaluation of science advisory processes. The framework is now in the early stages of being implemented and is expected to be fully in place by March 31, 2003.

4.2 STEWARDSHIP

A primary responsibility of governments is the protection and promotion of the public interest. Governments carry out this role by setting standards and regulations, and by developing policy directions based on the broad needs of society and the environment. Stewardship is the key instrument through which we build public acceptance of new technologies and products, and foster a vibrant marketplace. Stewardship is at the heart of good government.

By ensuring that innovation works hand-in-hand with the public interest, stewardship is essential to securing the quality-of-life improvements to be derived from new technologies and products. Effective stewardship involves establishing regulatory frameworks and codes for private and public sector conduct affecting public health and safety, the marketplace, and environmental sustainability. It also means using smart policies

Stewardship in Action

Stewardship is not solely the responsibility of government. However, governments are the agents charged with this responsibility. In fact, to be successful, any stewardship agenda must be based on the combined involvement of diverse players other than the government, such as the private sector, civil society and citizens. Below are three initiatives that illustrate how Canadian groups and institutions are coming together to show Canadian leadership in stewardship.

Canada's Strategy to Promote Safe, Wise and Responsible Internet Use. *This initiative was developed by the Government of Canada, in partnership with private, public and non-government organizations. Through this strategy, Canadian teachers and parents will be equipped with tools and resources to help them protect children against the dangers of illegal and offensive Internet content. This strategy has also led to the creation of a voluntary code of conduct for Internet providers to help protect consumers in the event that illegal content is inadvertently hosted on their computer systems.*

Canadian Biotechnology Advisory Committee (CBAC). *This committee, which is made up of Canadians from various backgrounds, was established by the Government of Canada to provide comprehensive advice to ministers on policy issues related to the ethical, social, regulatory, economic, scientific, environmental and health aspects of biotechnology. CBAC is also tasked with raising awareness and engaging Canadians in an open dialogue on biotechnology. Recent projects include research and consultations on the regulation of genetically modified food, and on intellectual property and the patenting of higher life forms. For more information, visit CBAC's Web site (**http://www.cbac-cccb.ca**).*

Mine Environment Neutral Drainage Program (MEND). *Canada's MEND Program was the first international multi-stakeholder initiative to develop scientifically based technologies to reduce the effects of acidic drainage, one of the biggest environmental issues facing mining companies around the world. Led by NRCan, with the participation of mining companies and associations and eight provincial*

Stewardship in Action *(continued)*

governments, this volunteer cooperative program established Canada as the recognized leader in R&D solutions for acid mine drainage, while realizing substantial financial benefits. An evaluation of the MEND program concluded that liability costs had been reduced by $340 million for five Canadian mine sites alone.

that encourage innovation and maintain incentives for business.

Some examples of stewardship include:

- testing food and drugs to ensure their safety (i.e. no harmful contaminants or unknown side effects);
- consulting Canadians on social, ethical, environmental and human health issues arising from breakthroughs in the area of life sciences;
- pursuing sustainable development and management of our natural resources;
- enforcing worldwide intellectual property protection for the works of Canadian innovators;
- adopting forward-looking environmental standards that require innovative solutions; and
- developing alternative measures of economic growth (e.g. an index of well-being that incorporates "negative" growth such as the environmental deterioration resulting from an industrial development project).

Effective stewardship is critical to a well-functioning economy. A firm's reputation and its value in the market can be adversely affected by the public's concern over its environmental practices or its ethical behaviour. If regulations are not clear and well enforced in areas such as intellectual property, then firms cannot invest confidently in higher risk projects. Although frictions between firms, civil society and governments are inevitable, all would agree that a well-developed stewardship regime is essential for our society to function effectively.

The stewardship challenges facing Canada today should not be underestimated. Protecting the public interest will be challenging as new discoveries push the boundaries of S&T and change our society. As new products become more complex and come on stream more quickly, our stewardship capacity will come under pressure.

Our ongoing stewardship priority should be to ensure that we are properly equipped to meet those challenges. If we expand our capacity to conduct best-practice stewardship, we will continue to provide Canadians with the assurance that their broader interests are protected. This will provide a more certain business climate and will spur innovative businesses to meet high standards. As other countries face the same stewardship pressures, we have an opportunity to leap ahead of the competition by setting the world's best standards.

4.3 FUTURE HUMAN RESOURCES CHALLENGES FACING SBDAs

The S&T community in the federal government strives to make valuable and focused contributions to the health, safety and sustained growth of the Canadian economy and job market.

Responding to the challenges of a knowledge-based economy, the management of federal S&T is evolving with new strategies and initiatives appropriate for

the new millennium. It is the S&T community's goal to nurture an S&T work force that is among the best in the world.

Understanding the Problems

There are many different but interrelated issues and challenges involved with the successful recruitment and retention of scientific personnel and technologists. The following is a brief list of the key issues for the community:

- management of the scientific work force,
- demographic trends, and
- employment equity.

Management of the Scientific Work Force

In 1998, the Human Resources Research Institute conducted a detailed research survey into the challenges facing Canadian organizations in the management of their R&D personnel. The results of the survey were published in the article, "Managing R&D Personnel: A Challenge for Canadian Organizations."[9] While the survey was not specifically targeted at the public sector, the results are consistent with the experiences of federal departments and agencies.

The survey found that organizations are especially challenged in their management of S&T employees. Four principle characteristics of S&T employees were identified.

- Employees are highly **powerful** in that they are a key facet of the organization's competitive advantage and, therefore, are likely to leave if their expectations and needs are not met. They are involved in innovative work that is difficult to control closely and are more subject to knowledge obsolescence.
- Employees are considered **individualists** given that they often prefer working on their own and often develop a significant attachment to their research work rather than their organization.
- S&T employees complain about a lack of **recognition** for their work. They would like to receive salary increases and promotions while continuing on a research career path. They also want more recognition from their immediate supervisor and from the management team.
- Employees want to maintain and improve their **competencies**. They especially want more time to attend lectures and conferences, and they want to be involved in more interesting work.

The survey recognized that S&T employees should be **distinctively managed**, since they are perceived to have unique job requirements. While the federal public service has managed certain scientific groups differently in some instances over the years, greater attention to the differences may be necessary to attract and retain new recruits.

Demographic Issues

Demographic issues lie at the heart of the challenge. In 1998, 1999 and 2000, the Public Service Commission of Canada (PSC) conducted a number of studies and a work force analysis of S&T personnel in the federal public service.[10] An initial scan of hiring potential over the five-year period 1998–2002 was performed using the Statistics Canada PERSIM (Personnel Simulation) model and other methods to analyze age distribution, departures and the distribution of employment equity groups.

9. Human Resources Management Research Quarterly, Winter 1999 edition.

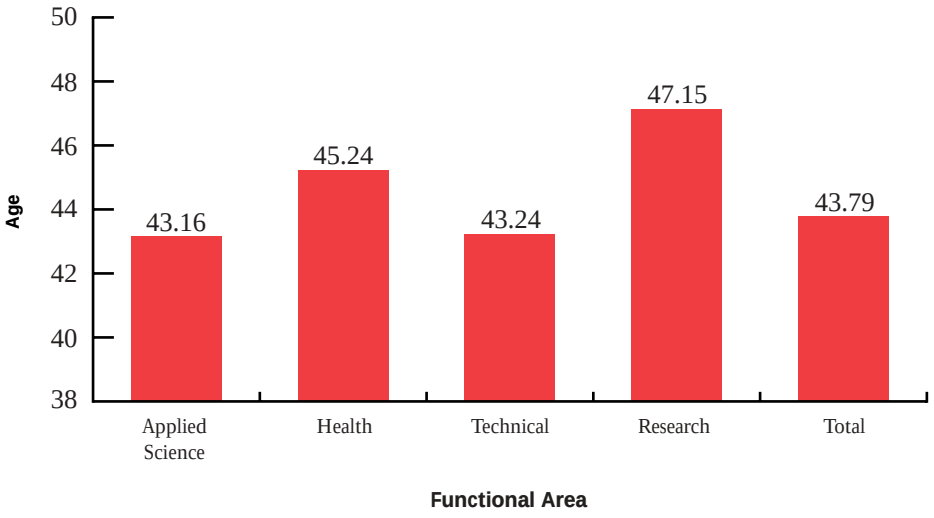
10. "Federal Public Service Scientific and Technical Community: Demographics, Employment Equity, Succession Planning" — 2000, "Demographic Analysis of the Scientific & Technical Community" — 1999, "Estimates of Hiring Potential: Scientific and Technical Community" — 1998. This report was prepared by an external contractor and is available in English only from the Interdepartmental S&T Community Management Secretariat.

The main finding of the demographic study was that the S&T work force is largely made up of older persons, not unlike the general population of the public service. In addition, the effects of Program Review have created significant impediments to the rejuvenation of the work force. Regular retirements and losses from those taking advantage of the special early departure programs during Program Review have resulted in a loss of critical expertise, both for employees and managers. In addition, the small number of researchers under the age of 40 has had an adverse impact, as this group is fresh from university and is often the source of new ideas.

Looking at the numbers in more detail, the study found that in 1997, more than half of all S&T employees were over 45 years of age (Figure 12). Assuming no recruitment, about 25 percent were projected to leave between 1998 and 2002, and the percentage of employees over 45 was projected to rise to 76 percent by 2002. Retirements were projected to account for about 65 percent of these departures. It was estimated that by 2005 the annual retirement rate would quadruple, causing a great loss in capacity, experience and managerial skills. The success of future recruitment will depend to some extent on the robustness of the economy outside the civil service.

Another issue that arose from the demographic study was the paucity of younger workers in the S&T community. Even in 1997, only 10 percent of the S&T community was under 35 years of age. This figure was predicted to drop to less than 5 percent by 2002, if hiring was not accelerated. Adding to the problem is the projection of a very tight labour market (labour demand exceeding labour supply) for many of the S&T occupational groups by 2002. This will result in the Public Service being in considerable competition with other sectors for the best and the brightest, exacerbating and

Figure 12: Average Age of S&T Work Force



Source: Public Service Commission, 2000.

enlarging a problem that already exists. This trend was evidenced as early as 1997, when the Public Management Research Centre surveyed more than 2500 students in more than 13 Canadian universities.[11] Of the students surveyed, only 18 percent stated a preference to work for the federal government, while 65 percent expressed a preference to work for the private sector. Clearly, a challenge exists to recruit and retain S&T employees under 35 years of age.

11. Ensuring a Modern and Effective Research and Science Capacity: A Graduate Opportunities Strategy, Consulting and Audit Canada, 2000. This report was prepared by an external contractor and is available in English only from the Interdepartmental S&T Community Management Secretariat.

Equity Issues

The S&T community has identified numerous equity issues of relevance to its members. Reviewing some of the equity group's issues individually, it was found that female employees are concerned about balancing work and personal life opportunities, and about leave, travel and relocation policies. The number of visible minorities occupying technical positions is far below labour market availability. Insufficient numbers of trained Aboriginals are available to ensure their appropriate representation in the federal S&T community. Lastly, persons with disabilities perceive significant barriers to their recruitment into the S&T community.

The general lack of recruitment over the last several years has also contributed to gaps in the representation of designated group members in the federal S&T community, compared to the Canadian labour market availability as a whole. Figure 13 illustrates the current challenges.

4.4 NEW MODELS FOR COLLABORATION AND PARTNERSHIP IN FEDERAL S&T

The federal government's Speech from the Throne in January 2001 laid out the bold challenge of moving Canada from 15th to among the top five internationally in the performance of R&D as a percentage of GDP. Under this scenario, the government committed to doubling its investment in R&D in the coming decade. Effective and productive partnerships between all sectors of society will be critical to Canada's success in reaching this objective.

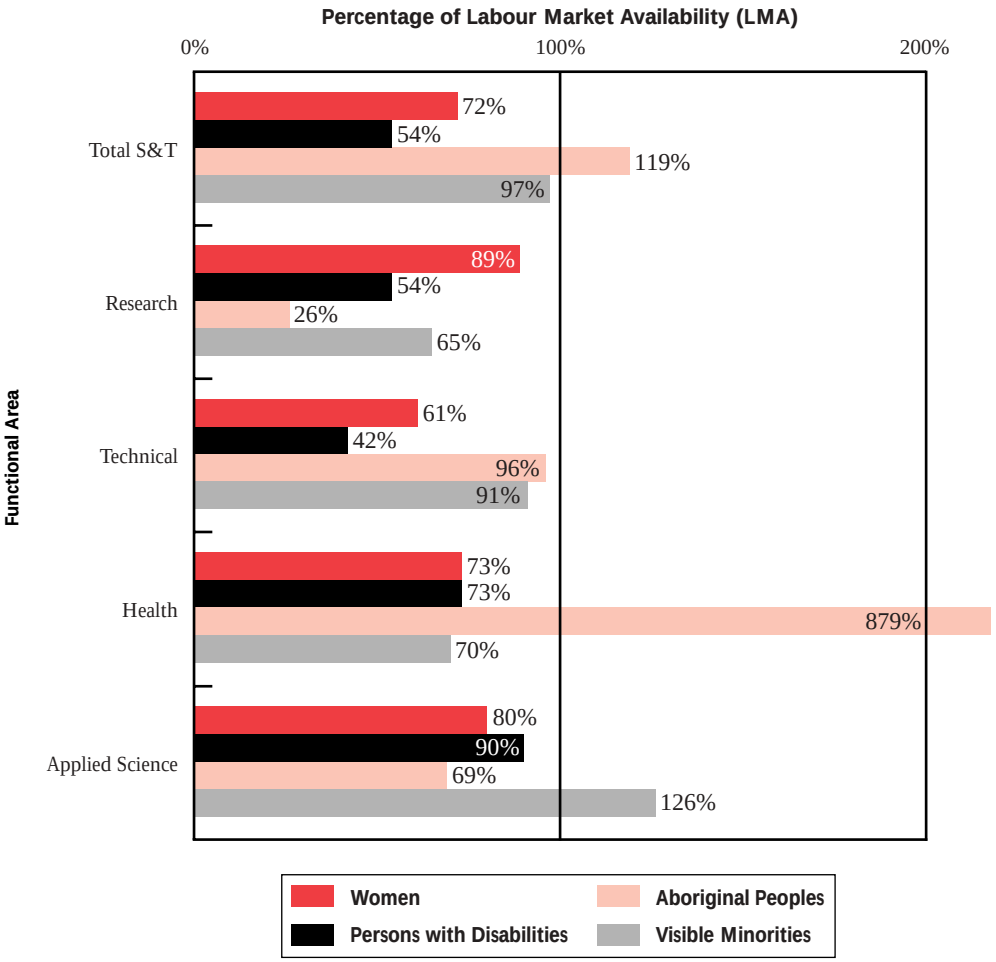
Despite the demonstrated value and success of federal government collaboration in S&T, the Council of Science and Technology Advisors reported the need to manage federal S&T resources more strategically with a horizontal approach across federal departments as a key step in fully integrating federally performed R&D into the national innovation system.

The following are examples of some of the new mechanisms for collaboration and funding of federal S&T that have arisen since the release of the federal S&T strategy in 1996. They are not all direct outcomes of the strategy, but most have been shaped by its principles. They all, however, contribute to an S&T policy environment that is fundamentally new and that poses new challenges for federal departments and agencies. The significant federal investments in S&T that have gone outside federal departments and agencies have helped to create strong capabilities in those sectors (university and industry), but the federal government is now challenged to make the best use of those capabilities for their own use (i.e. in place of in-house capacity).

Canada Foundation for Innovation

The Canada Foundation for Innovation (CFI) was launched in 1997 as an arm's-length independent corporation mandated to rebuild and reinvest in research

Figure 13: S&T Equity Groups



Source: Public Service Commission, 2000.

labs, installations and facilities in universities and teaching hospitals across the country. Through a series of investments, the government has committed $3.15 billion to the CFI. By 2010, it is expected that this investment will have resulted, through the participation of the institutions and their partners, in over $9 billion in new research capital investments.

It is proving to be very effective. By the end of 2001, the CFI had supported more than 1400 projects at 100 universities and hospitals. Every one of the projects funded to that date (over $900 million by October 2001) has enabled institutions to find matching funding from the provinces and additional monies from the private sector and the universities themselves. The CFI's funds are invested in partnership with research institutions and their partners in the public, private and voluntary sectors. Approximately 60 percent of the funds

are to come from the non-federal partners, resulting in both intergovernmental cooperation and the direction of federal funds to address priorities defined by those research-performing institutions, which employ Canada's major pool of researchers.

The result of these CFI investments is a rich variety of new projects, employing, attracting and, in some cases, repatriating Canadian students, researchers and technical staff who can then use their knowledge and expertise to strengthen the Canadian economy and ensure a better quality of life for Canadians. For more information, visit CFI's Web site (**http://www.innovation.ca**).

Canada Research Chairs

Another example of major capacity building outside of the federal government, but with federal funds, is the $900-million Canada Research Chairs program that will provide support for 2000 positions for researchers at Canada's universities across the country by 2005. The research chairs are a vital tool in assisting Canada's universities to maintain and build the research and training capacity they will need to fill the long-term demand for highly qualified people and research.

As a demonstration of the increasing integration of federal investments in S&T, the CFI will invest $250 million between 2000 and 2005 to provide chair holders with the world-class, leading-edge research equipment they need to compete globally and to train the next generations of Canadian researchers. For more information, visit CRC's Web site (**http://www.chairs.gc.ca**).

Genome Canada

Genomics research is an area where Canada has significant potential. The federal government has committed $300 million to Genome Canada for the creation of five research centres across the country. Each of these centres brings together industry, governments, universities, hospitals, research institutes and the public to put in place the research infrastructure and cross-disciplinary teams to address not only leading-edge technology development, but also to provide leadership in ethical, environmental, legal and social issues related to genomics. The Genome Canada centres demonstrate the new types of partnerships that are being undertaken by the federal government. Federal funding and expertise are leveraging participation from across the innovation system, and key decisions are being made by the genomics community as a whole, through open, transparent processes. For more information, visit the Genome Canada Web site (**http://www.genomecanada.ca**).

New Partnership Models are Being Explored

The Government of Canada continues to work hard on exploring new models for partnership and collaboration to change the way it carries out and delivers S&T. Drawing on the positive experience of the university-based Networks of Centres of Excellence program, federal SBDAs are exploring ways of better integrating their capabilities into Canada's system of innovation. They are striving to address nationally important emerging S&T issues and economic opportunities; bring together partners within and outside Canada to create networks for

National Institute for Nanotechnology (NINT)

The NINT is a unique partnership between the NRC, a leader in research, technology development and commercialization; the University of Alberta, a leader in research and education; and the Province of Alberta, committed to innovation and technology growth.

NINT will be a world-class centre for nanotechnology research that will attract a core of the world's best minds in a field expected to revolutionize everything from computing and communications to medicine, energy and manufacturing. While located in Alberta, NINT will have a national mandate to establish a world-class program in molecular and nano-scale science and engineering, technology transfer and commercialization. The institute will develop its research efforts with Canadian and international partners to focus on major opportunity areas.

innovation; and integrate R&D with policy application and commercialization. Led by federal scientists, these new collaborative approaches will focus attention on national priorities for federal S&T and on follow-through from R&D to innovative policies and products.

As a step towards improving protection against chemical, biological, radiological and nuclear incidents (CBRN), the **CBRN Research and Technology Initiative** (CRTI) was created to improve coordination and collaboration across three Canadian S&T sectors: government, private industry and academia. Funded by the federal government at $170 million over a five-year period, the CRTI is divided into three project categories: technology acquisition, technology acceleration, and research and technology development.

These new models will not only help leverage resources from across federal departments to address major national policy issues, they will also pull together and mobilize important players in the university, provincial and local governments, and the private sector, to increase the efficiency and impact of the results of efforts in R&D and innovation.

CONCLUSION

This report provides a five-year retrospective on the implementation of the federal government's S&T strategy, *Science and Technology for the New Century*. The strategy's three goals — sustainable job creation and economic growth; improved quality of life; and advancement of knowledge — have remained relevant to Canada's S&T needs in this new century. The commitment to the strategy on the part of all SBDAs was well-placed. Regardless of an SBDA's mandate, the common framework of operating principles, outlined in Chapter 2, was of considerable value in shaping their S&T activities to the emerging policy climate of the global, knowledge-based economy (KBE).

The strategy has guided us through turbulent times, through times of deficit to surplus. And with the continuing emergence of the KBE, and all the new pressures this entails for government, it continues to keep us on course.

The advisory and governance mechanisms that have been put in place since the strategy — regular attention to S&T issues by Cabinet committees, the Advisory Council on Science and Technology, the Council of Science and Technology Advisors, departmental science advisory boards, etc. — have provided the government with a firmer grasp of the importance of S&T to federal government activities and investments. They have also provided the nation with a federal S&T enterprise that is more integrated into the national innovation system.

The government has promised to at least double its investment in federal R&D by 2010, and it is off to a good start. However, of equal importance to increasing R&D spending, is investing S&T resources wisely to yield the highest return to Canadian society. This entails finding new ways of working together and boosting effectiveness and efficiency. It is clear that the strategy, both through its goals and its operating principles, is continuing to provide valuable guidance to departments, especially as they seek out new models for collaboration and partnership in federal S&T.

In the wake of the tragic events of September 11, 2001, the value of federal investments in S&T in maintaining our safety and security has come to the fore.

Federal scientists have been protecting us from insidious threats such as bioterrorism, as well as from the more mundane threats to our well-being — and they continue to do so today. The S&T strategy has provided a strong framework for federal S&T in its initial years. We anticipate that its guiding ideas will endure as the demands placed on the federal S&T enterprise continue to change and evolve in the future.

HIGHLIGHTS OF DEPARTMENTAL AND AGENCY PERFORMANCE

This section provides each science-based department and agency (SBDA) with an opportunity to showcase the science and technology (S&T) activities it carries out to deliver on its mandate. The activities described below cover the period from the launch of the federal S&T strategy in 1996 to 2001. The annexes link these activities to the operating principles of the strategy and allow SBDAs to follow up on the companion action plans that were produced at the launch of the strategy.

AGRICULTURE AND AGRI-FOOD CANADA

Science, Research and Technology Development, 1996–2001

As defined in the department's response to the 1996 federal S&T strategy, the fundamental reality shaping the sector — and its scientific requirements — is the marketplace. Science, research and technology development efforts continue to be fundamental to the department's commitment to Canadians and to its vision for the agriculture and agri-food sector.

The marketplace, however, has seen significant shifts in recent years. Consumer demands are changing. Consumers around the globe are more sophisticated, more knowledgeable and more discerning than ever before. They want assurances that new products created by advanced technologies and innovative practices are safe. They are concerned about the food they eat, the environment and the impact that agriculture has upon the environment. For all players in the sector — from primary producers to value-added processors — operating in the marketplace requires advanced technology and the latest knowledge in order for these consumer needs to be addressed.

In March 2001, federal, provincial and territorial ministers of agriculture met in Québec City and agreed on the urgency of working toward a flexible, comprehensive policy framework that will ensure security through research and innovation, and the management of all types of risk. Agriculture and Agri-Food Canada (AAFC) took the lead in developing the Agricultural Policy Framework (APF) that helped shape an action plan announced in Whitehorse in June 2001 as the first phase in preparing agriculture and the agri-food sector for the 21st century. Both levels of government continue their efforts to achieve agreement in the areas of renewal, environmentally sustainable agriculture, on-farm food safety and new approaches to science and safety nets.

Farming and food production have not shed their traditional risks. If anything, the risks of production failure have been compounded by increasing global competition; the potential for diseases and pests to spread across borders, regions and continents; and the impact of climate change. Existing risks to income are being compounded by new ones. Increasing attention is being paid to the role that science, research and technology development will play in improving the capacity of the sector to manage its risks.

The attitudes of citizens towards the marketplace have also changed. Service to the public interest is not seen as separate from the other goods delivered by markets and market forces. Instead, the message from citizens is clear: sustainable consumption and production are to be integrated with efforts to create economic opportunity and growth. A clear signal to the department in this regard was the 1999 Speech from the Throne, which emphasized the role of the federal government in contributing to the quality of life for all Canadians.

The department's response in recent years has been to adapt its policies and programs to keep pace with changes within the sector, as well as the expectations placed on all federal departments to contribute effectively to the national agenda. AAFC has also worked to develop and promote the adoption of new approaches to the management of risks. Lastly, the department has sought to improve the way it conducts science in order to prepare the sector for the challenges of the future and, at the same time, deliver benefits to Canadians in the areas of food safety, quality and the environment.

In 2000, after analysing and anticipating the evolution of the sector, and aligning itself with the government's overall priority of providing the best quality of life for all Canadians, the department redefined its business lines to focus on the following:

- security of the food system
- health of the environment
- innovation for growth.

The role of science remains central to achieving a balance between economic, social and environmental considerations by providing knowledge, information and advice both internally and externally, developing and transferring research and technology, and implementing policies and programs to achieve these objectives.

In fact, it was recognized that there is a strong need to develop governance structures for science that will integrate and link science planning and strategies with strategies for policy development, rural issues, and domestic and international trade. Strengthening the links between the scientific function and those of policy development and program delivery is necessary in the face of a wide spectrum of issues facing the sector, citizens and consumers.

Strengthening those links is critical. AAFC is working with the provincial and territorial counterparts, as well as with farm groups, to create a new, integrated and financially sustainable agricultural and agri-food policy.

The department is seeking to create an environment where S&T can flourish responsibly and safely. AAFC staff have recently been organized into horizontal teams with membership from the department's various branches — teams such as food safety, environment, science, trade, marketing and farm income. The teams are designed to address strategic priorities and will develop the plans to address the priorities in an integrated manner, develop budgets to support these plans and monitor the end performance.

To address these priorities in a comprehensive way, AAFC is refocussing its science, research and technology development activities. Research activities are being reorganized under the following four national research program themes:

- bioproducts and processes
- environmental health
- food safety and quality
- sustainable production systems.

This new approach will facilitate partnerships with researchers across the country.

Another influence on science priorities comes via the important process of seeking external advice. In the context of AAFC's realignment and the recent recommendations of the Council of Science and Technology Advisors, AAFC will require a broader-based science advisory body (SAB) to provide external advice to the department. This transition will be complete in 2002, through a department-oriented SAB with a broader focus and mandate.

In addition to connections with external advisors, the department is also promoting better connections across the full continuum of scientific and technology development disciplines. AAFC remains active in interdepartmental efforts to better integrate federally conducted S&T development through well-established mechanisms such as the Memorandum of Understanding on S&T for Sustainable Development in the Natural Resources Sector.

More recently, AAFC has been supporting the work of the federal S&T community in the development of the Federal Innovation Networks of Excellence (FINE) initiative. The department is also participating in the development of other themes that could be served by the network-based approach represented by FINE. For example, AAFC is leading the exploration of the science base for the regulation of biotechnology products. The main thrusts of FINE — the transformation of our approaches to the management of science and the alignment of our research activities with national goals — are consistent with those of the science component of the Agricultural Policy Framework (APF). AAFC will use consultations on the APF to engage partners in the development of FINE.

The department is also increasing its collaboration with partners outside of the federal science community. As just one example, AAFC and the Ontario Ministry of Agriculture and Rural Affairs, along with the private sector and the University of Guelph, have created a pilot project involving soybeans. The following two key outcomes are sought from this project:

- developing alternative uses for soybeans, higher up the value-added chain, to strengthen producer incomes; and
- optimizing the role of science in the value chain, from the farmer through to the consumer.

Contact Information

Science Policy and Planning Division
Agriculture and Agri-Food Canada
Tel.: (613) 759-7855
Web site: **http://www.agr.gc.ca**

ATLANTIC CANADA OPPORTUNITIES AGENCY

Main Accomplishments in S&T

One of the Atlantic Canada Opportunities Agency's (ACOA's) key strategic priorities is strengthening the innovation performance of small and medium-sized enterprises (SMEs) through the development and commercialization of new technologies and the growth of strategic sectors. Since the launch of the federal S&T strategy in 1996, ACOA has supported innovation in Atlantic Canada through:

- project-specific financing and advisory support for projects involving SME development, use and commercialization of technology, as well as infrastructure support to research facilities servicing SMEs;
- support to technology development and commercialization alliances;
- technology initiatives with partners; and
- the Atlantic Innovation Fund (AIF), launched in June 2001 (see "Strategic Directions in S&T" below for details).

Between 1996 and 2001, ACOA has invested over $155 million in innovation projects. These initiatives were undertaken as partnerships with stakeholders in the Atlantic system of innovation: private sector firms, research and academic communities, provinces and local communities.

Over the last several years, ACOA's innovation support to Atlantic SMEs has made a significant difference in the productivity and competitiveness of these firms. In the manufacturing sector, which accounts for almost half of ACOA's innovation clients, the productivity growth rate for innovation-assisted firms (37.7 percent) is more than three times the growth rate for unassisted firms (11.6 percent).[1]

During 2000–2001, ACOA undertook numerous specific initiatives to strengthen the innovation capacity of the Atlantic region. Foremost amongst these was the development of the $300-million AIF, officially launched in June 2001 after extensive research, policy development and consultations with stakeholders. The fund was announced as a component of the Atlantic Investment Partnership, a $700-million, five-year strategic investment package that supports initiatives in trade and investment, entrepreneurship and business skills development, and community economic development.

The objective of the AIF is to build the economy of Atlantic Canada by increasing the region's capacity to carry out leading-edge research and development (R&D) and contribute to the development of new technology-based economic activities. Specifically, the fund is aimed at augmenting the R&D being carried out in Atlantic research facilities, leading to the launch of new ideas, products, processes and services. The AIF is overseen by an advisory board comprised of knowledgeable academics, business leaders and experienced R&D/technology professionals, who make recommendations to ACOA's minister on specific project proposals.

The first request for proposals under the AIF closed on September 28, 2001, and generated a high level of response from the region's research institutions and business community. The agency received 195 proposals, seeking a total of $810 million toward total project costs of $1.5 billion. It is expected that successful projects from the first call for proposals will be announced during the first half of 2002.

The fund was designed to act as a catalyst in bringing together research institutions and private sector businesses around major investments in the R&D capacity of the region. The level of response demonstrated that the program successfully served this purpose. It further demonstrated that there is a significant gap between the demand for R&D investment dollars in the region and the existing resources that the Government of Canada has allocated to the AIF.

In addition to activities under the AIF, more than 30 new R&D and/or technology commercialization partnerships were established in 2000–2001. Some examples of these partnerships are cited here.

- The Centre for Marine and Aquatic Resources, established at the Atlantic Veterinary College on the University of Prince Edward Island campus, allows scientists to undertake applied and basic research that will position the university as a leader in aquatic and fish health research.
- ACOA participated with provincial and university research partners in providing matching funding under the Canada

1. Source: Statistics Canada.

Economic Diversification Agreements in all four Atlantic provinces, to assist a number of Canada Foundation for Innovation (CFI) projects demonstrating significant economic benefits to the region. For example, the Marine Environmental Prediction System at Dalhousie University will improve the ability to forecast physical, chemical and biological changes in the marine environment, and to assess the impact of climate changes and coastal development.

- The Nova Scotia Telecom Applications Research Alliance project received financial assistance from ACOA for its unique facility that combines leading-edge telecommunications R&D equipment with seed investment funding and business mentoring resources. Three new investment partnerships were initiated by this organization.
- ACOA supported the Atlantic Genome Research Centre in its early stages by providing financial assistance for business planning, marketing and administration. This assistance positioned the Atlantic Genome group to receive $9.57 million in funds from Genome Canada over three-and-one-half years for two large-scale genomics research projects and a DNA sequencing lab, in conjunction with the existing facility at the National Research Council Institute for Marine Biosciences.

Strategic Directions in S&T

ACOA will continue to work closely with its partners — businesses, the research and academic communities, provincial governments, and local communities — to enhance Atlantic Canada's capacity for innovation and technology development. The agency will concentrate its focus on the following three key areas:

- development and commercialization of new technologies
- building innovation capacity
- growth of technology clusters.

A number of strategic initiatives designed to strengthen innovation systems and increase innovation capacity will be undertaken to exceed the current level of activity and results in the three areas noted above. The AIF will be a key component to achieving results in these areas: it will help foster excellence in innovation, create new business opportunities, stimulate export-based growth, and provide many Atlantic Canadians with enhanced skills and good quality jobs.

Contact Information

Atlantic Canada Opportunities Agency
Tel.: (506) 851-2271
Web site: **http://www.acoa-apeca.gc.ca**

CANADA ECONOMIC DEVELOPMENT FOR QUEBEC REGIONS

Main S&T Accomplishments

Since April 1, 1996, Canada Economic Development for Quebec Regions (CED) has awarded grants totalling $92 million under the Innovation, Research and Development component of its IDEA-SME program and the technological components of its Regional Strategic Initiatives.

In 2000–2001, CED contributed to the development of the innovation capabilities of more than 1220 small and medium-sized enterprises (SMEs). Also, it supported the carrying out of 162 projects for the development of new products and services. The projects presented below illustrate the variety of CED actions in these areas.

- The Canadian Technology Network, funded by various federal departments including CED, responded to 790 requests for technological information from Quebec enterprises.
- CED contributed to the development of innovation capabilities in a variety of ways, including information activities related to technological applications. These sessions, carried out in collaboration with Valotech, have brought together 290 participants.
- CED funded an enterprises-researchers brokering service aimed at the chemicals and plastics industries. This pilot project, which was implemented with the help of McGill University, has put 45 enterprises in touch with scientific and technological resources suited to their needs.
- CED renewed its financial support for the Operation SME program carried out with the Ordre des ingénieurs du Québec. It also supported another initiative of the same kind in eastern Quebec and the North Shore area. This assistance has enabled nearly 95 SMEs, operating mainly in regions far from the major urban centres, to acquire personnel with technological skills and to enjoy the services of science and engineering graduates, students or physics technicians.

To strengthen the competitive advantage of Quebec communities and regions, CED supported the carrying out of

initiatives in the knowledge economy field (research centres, transfer of technology, etc.). Significant progress was made towards fulfilling CED's commitment to this objective:

- CED financially supported the National Optics Institute in carrying out an optics and photonics research program. The program generated 183 new jobs in 2000–2001 and sales of expertise worth $10.5 million.
- CED also funded the Centre de recherche informatique de Montréal to help SMEs improve the quality of new software and minimize the risks connected with their marketing. During the year, 17 software tests were done.
- In 2000–2001, CED contributed to consolidating the activities of the Centre de développement rapide de produits et de procédés of the École Polytechnique de Montréal, which assists innovative SMEs. The centre conducted awareness and technology transfer activities aimed at SMEs in the fields of rapid development of products, tooling and prototyping. Lastly, it organized a dozen events attended by more than 500 people, as well as four seminars that attracted 240 participants.
- CED contributed to the applied research of the Consortium de recherche sur la forêt boréale commerciale in the Saguenay-Lac-Saint-Jean region.
- CED funded feasibility studies in connection with seven research centres or technology transfer projects (submissions to the Canada Foundation for Innovation), including a project to establish a virtual reality research centre by the Université du Québec à Hull, an industrial-ecology technology transfer in Montérégie, and a number of projects initiated by McGill University and the Université de Montréal. The latter two feasibility studies led to concrete developments and investments amounting to about $116 million.

In cooperation with the National Research Council of Canada (NRC), CED participated in the implementation of two collective initiatives to establish specialized research centres:

- The first, in Saguenay-Lac-Saint-Jean, is designed to strengthen Canada's position in the second- and third-stage processing of aluminum. It will support SMEs in their efforts to adopt new technologies and become more competitive, and to attract 80 researchers to the region.
- The second, on the campus of the Université de Montréal, will focus its research on improving advanced aerospace manufacturing technologies and methods.

The costs of these two initiatives are supported collectively by CED and the NRC.

Strategic Directions in S&T

CED will contribute to improving the support environment for the development of regions of Quebec during the 2001–2004 period by promoting knowledge-based competitive advantages:

- ten research or technology transfer institutions will be established or developed further; and
- ten nominations will be sought for the establishment of research or technology transfer centres.

CED believes that improving the level of knowledge and skill in business is crucial for increasing competitiveness and innovation capabilities. In this context, CED will help enterprises build on the new business practices to maintain and strengthen their competitiveness:

- 70 SMEs will be made more aware and supported in their management of sustainable development and the environment.

CED will increase the ability of SMEs to adapt and test a new or improved product, service or innovative production process:

- 1700 SMEs will be made more aware of technological innovation and productivity;
- 1200 SMEs will be visited by an engineer to evaluate their technological capabilities;
- 60 technology and knowledge-based SMEs will be given access to conventional funding;
- 125 diagnostics will be conducted to improve productivity; and
- 300 product or process development and productivity improvement projects will be supported.

Contact Information

Advocacy and Industrial Policy
Canada Economic Development for Quebec Regions
Tel.: (819) 997-1287
Web site: **http://www.dec-ced.gc.ca**

CANADIAN FOOD INSPECTION AGENCY

The Canadian Food Inspection Agency (CFIA) was created in 1997 to consolidate the delivery of all federally mandated food inspection, plant protection and animal health programs. The agency strives to be a leading science-based regulator recognized internationally for its scientific stewardship and excellence in policy development, program design and regulatory decision making. Over the past four years, the agency has strengthened its S&T capacity in the face of increasing global challenges and a more complex food safety environment.

The following information highlights the agency's contributions in meeting the commitments of the federal S&T strategy.

Commitment to Federal S&T Initiatives

The CFIA fully supports the principles and guidelines articulated in the Council of Science and Technology Advisors' *Science and Technology Excellence in the Public Service (STEPS)*, *Science Advice for Government Effectiveness (SAGE)*, and *Building Excellence in Science and Technology (BEST)* reports for sound science advice in public policy development. This is demonstrated by the creation of the Science Evaluation Unit in 1998, to coordinate science activities within the agency and to provide advice and recommendations on science issues to the president and the executive committee. The unit represents the agency on federal S&T initiatives, through participation in groups such as advisory councils and interdepartmental working groups. It oversees the overall implementation of the recommendations of the SAGE report into the agency's priority setting and decision making.

Enhancing the Effectiveness of Federal Science Support

The agency has 21 laboratories that provide research, advice and analytical testing of chemical, microbiological and physical entities that underpin the science-based decision-making and standard-setting activities of the agency. Over the past year, the agency has initiated several new initiatives such as laboratory integration, resource and technology development reviews to strategically plan its S&T capacity (including partnership and collaborative arrangements, identification, and maintenance of core skills and expertise), and targeted R&D initiatives in support of program needs.

To demonstrate our commitment to the quality of our science, the laboratories within the CFIA have implemented ISO 17025 "General Requirement for the Competency of Testing and Calibration Laboratories." Numerous labs are accredited by the Standards Council of Canada to this standard, with a commitment that the remaining laboratories will be accredited in the near future. In addition, many of the labs that conduct research have also decided to embrace quality systems and are accredited for this area of our business.

National Centre for Foreign Animal Diseases

The National Centre for Foreign Animal Diseases (NCFAD), a joint initiative of the CFIA and Health Canada, was unveiled in June 2000 as a part of the Canadian Science Centre for Human and Animal Health in Winnipeg. This complex, the first in the world, houses both human and animal health research, and is also one of few facilities internationally that can diagnose and investigate foreign animal diseases of potential threat to Canadian livestock. The NCFAD provides virology, serology, pathology and microbiology testing services for detecting the transmission of foreign animal diseases exotic to Canada, and confirmatory testing, reference, epidemiological, and traceback requirements of livestock intended for either import or export. Importantly, the NCFAD also maintains a state of readiness for laboratory confirmation of foreign animal diseases and conducts training courses for veterinarians in this field.

Linking up Science and Intelligence Nationally and Globally

The CFIA emphasizes a preventive approach to food safety, animal health and plant protection. In support of this endeavour, the agency actively builds intelligence networks nationally and internationally to facilitate intelligence gathering and the early detection of pests and diseases that could be of economic concern if introduced and established in Canada. An example of these initiatives is the Canadian Animal Health Network (CAHNet). The CAHNet links together the disease-detection capabilities of practicing veterinarians, and provincial and university diagnostic laboratories.

In addition, the agency is actively involved in international standards, developing and encouraging the adoption of science-based sanitary and phytosanitary requirements. This work is conducted through participation in multilateral organizations such as the World Trade Organization, Codex Alimentarius, the North American Plant Protection Organization, the international Plant Protection Convention of the Food

and Agriculture Organization, and the Office international des épizooties.

Emergency Preparedness and Prevention

The creation of the CFIA brought together five distinct emergency management cultures. The Office of Emergency Management provides overall coordination of the CFIA's policy development to address the elements of prevention, preparedness, response and recovery. The office supports Emergency Preparedness Canada, while ensuring the contingency planning and response capabilities at all levels are complete, current and functional. The CFIA has jointly established with Agriculture and Agri-Food Canada the Food and Agriculture Emergency Response System, designed to link the federal, provincial and private sectors to better manage and coordinate responses to food, animal and plant health emergencies.

In 1999–2000, the Office of Food Safety and Recall was created to coordinate food emergency response with CFIA staff across Canada and internationally. The OFSR functions as the main point of contact for other jurisdictions dealing with food emergencies and is the lead CFIA office in the agency's response to foodborne illness outbreaks.

Environmental Sustainability and Regulating Biotechnology Products

Environmental protection and sustainable development are an integral part of the CFIA's legislative responsibilities related to food, plant protection and animal health. The CFIA works with industry to develop internationally acceptable national organic standards, recognized validation processes, and certification and accreditation mechanisms. The direction for the CFIA's Environmental Management Plan was approved in June 1998, and the agency has committed itself to developing and implementing an Environmental Management System in an effort to integrate environmentally responsible approaches to the management of its physical operations.

The agency conducts environmental assessments to determine potential environmental effects related to feeds, fertilizer, seeds and veterinary biologics, as well as all agricultural products of biotechnology that are intended to be released into the environment. In Budget 2000, the Government of Canada committed $90 million to enhance and improve the federal regulatory capacity. The CFIA's Office of Biotechnology played an important role in the identification of the key regulatory priorities and program initiatives by the six departments and agencies receiving this funding. This funding will support the CFIA in scientific research to address emerging issues in biotechnology, including environmental research and molecular biology. The outcome will be timely policy development and product-safety assessments in biotechnology.

Fight BAC!™ and the Advancement of Scientific Knowledge

In December 1997, the Canadian Partnership for Consumer Food Safety Education was formed with membership from industry, consumer groups, the CFIA and other government agencies. The goal is to develop and implement a comprehensive food safety education campaign aimed at increasing consumer understanding of foodborne illness and what can be done to decrease its occurrence.

In April 1998, the partnership continued its efforts to combat foodborne illness and extended its activities by implementing education programs aimed at school children. This work resulted in the launching of the Fight BAC!™ campaign, a unique food safety program for children from kindergarten to Grade 3. The material, which can be used by teachers, group leaders, nurses and others, illustrates key steps in the safe handling of food and includes take-home messages to educate parents. This material, along with other food safety information such as recalls, health hazard alerts and factsheets, is available on the CFIA Web site.

Partnering with the University of Guelph and Building for the Future

In the effort to develop networks to link skills and talents in S&T, in 2000, the CFIA embarked on a collaborative and partnership arrangement with the University of Guelph in the creation of the Canadian Institute for Food Inspection and Regulation (CIFIR), a unique Canadian research and educational program in food safety management. The CIFIR is a three-year pilot project that will benefit Canadian students and possibly establish the institute permanently at this university. The CIFIR will coordinate and facilitate activities, act as a clearing house for information between the two organizations, guide their collaborative projects, as well as attract and secure R&D funding from the private and public sectors. The agreement includes employment by the CFIA for students enrolled in the cooperative student education program, the establishment of

a CFIA President's Scholarship for graduate students in biotechnology, and support for other science programs.

Another example of the CFIA's commitment to building a strong S&T capacity for the future is the establishment of the Officer Training program. This program was established in June 2001, to orient recent post-secondary graduates to the business of the CFIA and to help them make career choices in a S&T-related discipline. The CFIA will add to this effort with a campaign aimed at recruiting veterinarians into the organization.

Contact Information

Science Evaluation Unit
Canadian Food Inspection Agency
Tel.: (613) 225-2342
Web site: **http://www.inspection.gc.ca**

CANADIAN INSTITUTES OF HEALTH RESEARCH

In June 2000, the newly formed Canadian Institutes of Health Research (CIHR) replaced the Medical Research Council of Canada (MRC) and Health Canada's National Health Research and Development Program. CIHR's legislated mandate is "to excel, according to internationally accepted standards of scientific excellence, in the creation of new knowledge and its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian health care system."[2] The mandate of CIHR has been expanded beyond that of the MRC to embrace all four pillars of health research:

- biomedical science
- clinical science
- health services and systems research
- social, cultural and environmental determinants of population health.

CIHR consists of 13 virtual institutes working together not only to create new knowledge but also to translate that knowledge into improved health for Canadians. This new and expanded mandate will be achieved through CIHR's ongoing support of Canada's health research community. By means of grants, awards and partnerships, CIHR funds research into the cures and causes of disease, the societal factors determining disease, the techniques and technologies that improve health service delivery, and solutions to health disparities amongst vulnerable populations.

As well as increased funding for training and the open grant competitions that were the hallmark of the MRC, CIHR's 13 institutes are charged with identifying Canada's health research priorities and then providing funding for strategic investments in health research to advance knowledge critical to improving the health of Canadians. As the principal vehicle for achieving CIHR's expanded mandate, these institutes include all major disciplines in health research organized into related, interdisciplinary institutes. The president and governing council of CIHR report to Parliament through the Minister of Health.

Major S&T Achievements

During the 2000–2001 fiscal year, CIHR supported 3326 operating, clinical trials, equipment and maintenance, and other grants and awards totalling $265.45 million. CIHR also supported 587 salary-support grants and awards totalling $29.2 million as well as 1628 research-training grants and awards totalling $32.5 million.

CIHR also launched a number of major new S&T initiatives this year:

- **Interdisciplinary Health Research Teams (IHRT)** — IHRTs are interdisciplinary, multi-centre collaborations between at least two of the four themes or pillars of health research. Each focusses on an important health problem, with an emphasis on research translation between disciplines. Eleven IHRT awards have been granted across Canada to fund interdisciplinary research in areas such as cancer, seniors' health, health benefits of women's caregiving, autism, addiction, rural and maritime health, primary health care for children and adolescents, and genetics.
- **Community Alliances for Health Research (CAHR)** — This program, delivered in collaboration with the Social Sciences and Humanities Research Council of Canada (SSHRC), facilitates mutual learning and collaboration among community organizations and partnerships with researchers based in local universities, hospitals and other not-for-profit

2. Bill C-13, Section 4, C-6, R.S.C. 2000.

institutions. In addition to contributing to the improved health and quality of life in communities involved in CAHR, the program provides unique opportunities for training health researchers in all disciplines. Nineteen CAHR awards have been made to research teams in multidisciplinary environments, including child welfare, the Canadian healthcare workplace, First Nations' health, suicide prevention, child and youth mental health and injury prevention, rural health, community genetics, health promotion and physical activity, marine and coastal health, and women's unpaid caregiving.

- **CIHR Strategic Training Initiative in Health Research** — The objectives of the CIHR Strategic Training Initiative in Health Research are to build a culture of creativity, innovation and transdisciplinary research within the next generation of health researchers; encourage and enable highly motivated individuals from Canada and abroad to undertake training in health research in Canada; support the development of innovative, effective and competitive transdisciplinary training programs in health research in Canada; and support health research training in areas where it can be demonstrated that there is a need to develop capacity. Over 130 letters of intent have been approved for full application with final awards to be announced early in 2002. It is anticipated that this new investment in multidisciplinary health research training will provide Canada with the capacity it needs to lead health research in the 21st century.

- **Global Health Research Initiative (GHRI)** — GHRI is a partnership among CIHR, the International Development Research Centre, Health Canada and the Canadian International Development Agency. GHRI seeks to understand the "10/90 Gap" in which 90 percent of the world's health research dollars are spent on diseases affecting 10 percent of the global population. This gap has resulted, in part, in the health disparities between the North (developed countries) and the South (developing countries). GHRI will determine Canada's role in addressing the 10/90 Gap first by examining root causes of health disparity and then developing joint programs aimed not only at the downstream burden of disease solutions (i.e. the availability of affordable medicines and health care) but also solutions to upstream determinants of health (e.g. education, health promotion).

- **Technology Commercialization** — In collaboration with the Natural Sciences and Engineering Research Council of Canada (NSERC) and SSHRC, CIHR has renewed the Intellectual Property Management Program, which provides operating grants to technology-commercialization offices in Canadian research institutions. In addition, CIHR has launched the Proof of Principle Program to provide research grants to add value to early stage technologies that are being managed by the institution's technology-commercialization office. CIHR and NSERC have also supported WestLink, an Edmonton-based organization that provides intern and training services to technology-commercialization personnel in western Canada.

Contact Information

Canadian Institutes of Health Research
Tel.: (613) 941-2672
Web site: **http://www.cihr.ca**

CANADIAN MUSEUM OF NATURE

The Canadian Museum of Nature (CMN) is Canada's national museum for natural history. It cares for a collection of over 10 million specimens and provides new knowledge through systematics research, which is divided into four main areas: paleobiology, biodiversity, mineralogy, and collection management and conservation. The CMN conveys this information to the public through educational media, displays and exhibits, and programs. The results of CMN research are directly applicable to resource use and planning for sectors such as the mining industry or through initiatives such as the Canadian Biodiversity Strategy or deliberations of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

CMN research staff provide scientific advice to, or are present on, a number of governing committees, including COSEWIC, the Ecological Monitoring and Assessment Network, the Canadian Committee for the IUCN (the World Conservation Union), the Biological Survey of Canada, the Pan-Arctic Flora Project and the International Mineralogical Association.

Major or Ongoing S&T Activities

For the past three years, the CMN has served as the chair of the Federal Biosystematics Partnership (FBP), which is undertaking two key projects. The first is a needs assessment for systematics expertise in Canada, beginning with those of the partners (Agriculture and Agri-Food Canada (AAFC), Environment Canada, Fisheries and Oceans Canada, Natural Resources Canada, Parks Canada and CMN). The second project involves acting as the Canadian lead for participation in

the new Global Biodiversity Information Facility (GBIF). AAFC is spearheading the GBIF activity on behalf of the FBP, which includes negotiating the membership agreement, establishing a governing board and governance structure, staffing and establishing all the national criteria for a voting membership.

The CMN is one of the founding members of COSEWIC and continues as a member in the renewed committee structure. Dr. Robert Anderson is the museum's official representative on COSEWIC. As well, Dr. Claude Renaud is co-chair of the Freshwater Fish Species Specialist Group.

The CMN is beginning consultation with stakeholders and clients to develop a national collections plan. This plan will determine how the collections at the CMN can enhance our national heritage and will provide guidelines for their growth. To date, presentations have been made to the Canadian Botanical Association, and the draft plan has been forwarded to the Canadian Society of Zoologists.

The CMN continues to work with the Biota of Canada Information Network, a multi-partner project that will provide on-line Web access to collections and wildlife-sighting data of the flora and fauna of Canada. CMN is leading and facilitating the Birds of Canada module, in partnership with major natural history museums, the Canadian Wildlife Service and Bird Studies Canada. Also in the area of informatics, the CMN is collaborating with the Canadian Heritage Information Network (CHIN) to centralize public access to museum objects and natural history collections. Over the past year, CMN has sent 14 500 palynology (pollen and spore) records to CHIN.

CMN shares its scientific expertise on collection management and conservation issues with other institutions in Canada and around the world. In 2000, Chief Conservator Rob Waller provided a workshop at the Smithsonian Center for Material Research and Education, and presentations in Sweden and Hong Kong.

With the participation of the three national granting councils (Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada, and the Canadian Institutes of Health Research), a working group chaired by the CMN produced guidelines for best practices in collection, management and conservation of natural science collections. The guidelines are available at the NSERC Web site.

One way that the CMN reaches the public is through its award-winning Web site, nature.ca. In 2000–2001, the site received over two million unique visits, and staff responded to over 1000 information requests received via the site. The CMN also offers educational programming in natural sciences through exhibitions in Ottawa and on the road, through classroom presentations and interpretative programs to school-aged children.

In 2000–2001, the CMN wrapped up a community-based research project to monitor biodiversity in the Rideau River. It developed an advocacy group for members in the community to carry on the work following the initial research. This model of community-based science is a useful guide for future work by museums and others, and a special interest group of the Canadian Museums' Association is developing it further.

The CMN's staff of experts in systematics research and collections produces about 1 percent of all scientific refereed publications each year by federal science experts (about 40 per year). The CMN receives hundreds of scientific visitors and students (graduate and undergraduate) annually at its research and collection facility, the Natural Heritage Building located in Aylmer, Quebec. CMN experts are part of, or provide support to, a range of professional organizations. These include adjunct professorships at eight Canadian universities; membership on several editorial boards; the assistant directorship at the Bamfield Marine Station (B.C.); the chairperson for the New Minerals Naming Committee of the International Mineralogical Association; and members on the executives for the Society of Vertebrate Paleontologists, International Diatom Society, Canadian Society of Zoologists, the Coleopterists Society, and the Biodiversity Science Board (Environmental Monitoring and Assessment Network).

CMN houses and supports the Biological Survey of Canada (Terrestrial Arthropods) and has done so for over 20 years. The survey helps to coordinate scientific research among specialists in the Canadian fauna of insects, mites, and their relatives. It serves as a catalyst for more efficient scientific progress and provides national direction for work on Canada's insect fauna. CMN also houses and supports the Secretariat for the Canadian Committee for the IUCN. The Secretariat was the focal point for the committee's work leading to the second IUCN World Conservation Congress, October 2000, in Jordan. The CMN also houses the Secretariat for the Medicinal Plant Specialist Group of the IUCN Species Survival Commission.

In 2000–2001, CMN provided the Canadian representative to the Co-ordination Mechanism for the Global Taxonomy Initiative. As well, CMN botanist Dr. Susan Aiken is representing Canada on the Panarctic Flora project, an international initiative to itemize all arctic flora and to further understand which species are rare and endangered.

Through its Canadian Centre for Biodiversity, the CMN continues to provide biodiversity training and education for various audiences and to develop tools that can be used in communities for biodiversity inventories and monitoring, leading to environmental stewardship and decision making. The CMN was the lead organizer of a special workshop on the role of museums in environmental education and sustainability, and continues to play a key role as coordinator and facilitator between the Canadian museum community and the national efforts of Environment Canada, among others.

Contact Information

Research Services
Canadian Museum of Nature
Tel.: (613) 566-4743
Web site: **http://www.nature.ca**

CANADIAN SPACE AGENCY

The Canadian Space Agency (CSA) was created in 1989 to promote the peaceful use and development of space, to advance the knowledge of space through science, and to ensure that space S&T provides social and economic benefits for Canadians. The CSA coordinates all aspects of the Canadian Space Program (CSP). It delivers services involving Earth and the environment, space science, the human presence in space, satellite communications, generic space technologies, and space qualification services and awareness.

Action Plans and Strategies

The 1996 Industry Portfolio Action Plan indicated that, under the new CSP approved in June 1994, the CSA would undertake several important new initiatives. Priority would go to developing and applying space technologies in Earth observation and communications. To ensure commercial success, federal funds would be maximized through partnerships with the provinces and through innovative financing. The program would be opened to more firms, particularly small and medium-sized enterprises (SMEs). Sustainable regional industrial development would also be pursued. The following are some significant initiatives stemming from the 1996 Action Plan that CSA has addressed over the years. (The 1996 Action Plan commitments appear in italics.)

Strategic Space Technology Diffusion Program

The CSA will strengthen its technology transfer activities. This program will promote the exploitation of space technologies. The Canadian Space Technology Commercialization Network will be a key node in the Canadian Technology Network.

The CSA created the Commercialization Office with a mandate to promote and exploit the commercial potential of space capabilities, technologies, facilities and systems. Its aim is to maximize the social and economic benefits of the CSP. The office's main functions are to manage the intellectual property of the CSP and to support technology transfer. The CSA is now an active member of the Canadian Technology Network.

Partnerships

The CSA will conclude arrangements with the private sector to build and commercially operate RADARSAT-2 and its successors. The CSA will also develop a new generation of advanced satellite communications technologies to provide new wideband and personal communications services.

In December 1997, the Government of Canada announced contracts had been awarded to five Canadian high-tech companies for the development of innovative satellite communications technologies. The contracts were awarded through the CSA's Advanced Satellite Communications Program, a program implemented in cooperation with the Communications Research Centre of Industry Canada. Between 1999 and 2001, additional contracts were awarded to Canada's space industry for multimedia satellite-based technologies designed to bridge the gap between urban and remote regions of the country. In January 1998, MacDonald Dettwiler of Richmond, B.C., and the federal government successfully concluded their negotiations to construct and operate RADARSAT-2. It will be the most advanced commercial Synthetic Aperture Radar satellite in the world.

International Cooperation

The CSA will put in place organizational structures to help industry market internationally and develop business services. International cooperation is integral to all major space projects and programs.

Canada's high level of S&T expertise is recognized globally and has established Canada as a reliable partner on the international scene. Such recognition has enabled us to participate in various joint programs with many countries, including the U.S., France and Japan. Furthermore, the CSA provides strategic and timely information and support to industry and other Canadian stakeholders. Key mechanisms and tools in place include the National Sector Team on Space, the Canadian International Business Strategy, the Global Space Sector Market Trends, the State of the Canadian Space Sector, the daily space news briefs, and the Directory of the Canadian Space Sector.

Science Culture

The CSA will advance the unique appeal of space as a medium for improving scientific literacy and promoting S&T careers amongst youth. Its coverage will include fellowships to perform industry-led research in CSA's facilities. Existing institutions will diffuse educational material in all regions of Canada.

Under the Education and Youth Awareness Program, the CSA produces information and learning-based materials, turnkey teaching packages, and virtual presentations focussing on the science and mathematics of space. The CSA collaborates with the science-centre community across the nation to bring extra-curricular space content and experiential learning opportunities to Canadians of all ages. Also, the CSA established a series of fellowships and scholarships, including the CSA Postgraduate Supplements in Space Technology and the Scholarship Supplements in Space Science Program. It participates in the Visiting Fellowship in Canadian Government Laboratories Program and the Youth Space Awareness Grants and Contributions Program.

Performance Measurement

The CSA is developing performance indicators to improve the effectiveness of its programs as well as to establish clearer goals, monitor progress and reward achievements.

The CSA operates the following seven service lines:

- space science
- Earth and environment
- the human presence in space
- satellite communications
- generic space technologies
- space qualification services
- comptrollership and awareness.

For each of these lines, CSA's performance is evaluated on the basis of a series of key results commitments: economic benefits, understanding of the environment and contribution to sustainable development, contributions to the quality of life, technological development and diffusion, world-class space research, social and educational benefits, and promotion of the CSP.

Management Framework

A new management framework has been developed as part of the 1999 New Space Plan. Its objective is to engage stakeholders in the development and implementation of CSA programs, and to facilitate their visibility and input in the assessment of program performance. Under the framework, the CSA Advisory Council advises the CSA President on CSP's overall strategic direction; the Service Line Advisory Groups advise the CSA on plans, priorities and strategies for each of the service lines; and the Program Management Boards ensure coherent and efficient delivery of projects and programs jointly implemented by CSA and other government departments. The management framework is also supported by the Interdepartmental Committee on Space, comprised of all federal departments with an interest in our national space program.

Major Achievements 1996–2001

1996–97

- Marc Garneau aboard *Endeavour* became the first Canadian to return to space
- Robert Thirsk performed life-science experiments aboard *Columbia*

1997–98

- Bjarni Tryggvason aboard *Discovery* performed experiments on the Microgravity Vibration Isolation Mount
- RADARSAT-1 acquired the first high-resolution satellite images ever taken of the South Pole

1998–99

- MacDonald Dettwiler of Richmond, B.C., and the federal government successfully concluded negotiations to construct and operate RADARSAT-2

- Dave Williams participated in the Neurolab space life-science mission aboard *Columbia*
- Japanese spacecraft Planet-B launched to Mars with Canada's atmospheric probe, the Thermal Plasma Analyzer, onboard

1999–2000

- New space plan launched following the government's decision to provide the CSA with additional funding
- Julie Payette aboard *Discovery* became the first Canadian to visit the International Space Station (ISS)
- NASA's Terra Satellite launched with CSA's MOPITT (Measurements of Pollution in the Troposphere) instrument to perform a checkup of our planet's land, oceans and atmosphere

2000–2001

- Marc Garneau aboard *Endeavour* visited the ISS and installed a pair of solar panels using the Canadarm and the Canadian Space Vision System
- Canada renewed its membership in the European Space Agency with the signing of a ten-year Cooperative Agreement
- Chris Hadfield became the first Canadian to walk in space, on a mission to install the Canadarm2, Canada's contribution to the ISS

Contact Information

Government Liaison Office
Canadian Space Agency
Tel.: (613) 993-3771
Web site: **http://www.space.gc.ca**

DEFENCE RESEARCH AND DEVELOPMENT CANADA

Defence Research and Development Canada (DRDC) became a Special Operating Agency within the Department of National Defence (DND) in April 2000. We have recast our operating procedures, programs and mission to better serve Canada's defence and national security needs. These changes are consistent with the principles and goals of the federal S&T strategy.

The key objective of DRDC is to ensure that the Canadian Forces remain technologically prepared and relevant. Our new vision is to be known worldwide as the best in defence R&D. Last year, the department invested $172 million in DRDC. The agency used $90 million to fund the participation of Canadian industry and universities in the delivery of its R&D program.

DRDC's activities are conducted along the following four business lines:

- R&D for the Canadian Forces and DND
- strategic S&T policy and advice
- S&T with national security partners
- corporate management.

DRDC has responded to new defence and security challenges through R&D based on a new Technology Investment Strategy. This strategy identifies technology drivers that will enable new defence capabilities. It also sets out R&D activities that will harness these technologies through in-house R&D, by adapting civilian or allied technology, through collaboration with industry and academia, and through cooperation with our allies.

The Technology Investment Strategy

- Autonomous Intelligent Systems
- Command Effectiveness and Behaviour
- Emerging Materials and Bio-Technologies
- Human Factors Engineering and Decision Support Systems
- Information and Knowledge Management
- Network Information Operations
- Signature Management
- Simulation and Modelling for Acquisition, Requirements, Rehearsal and Training
- Space Systems
- Chemical, Biological, Radiation Threat Assessment and Identification
- Command and Control Information Systems
- Communications
- Electro-Optical Warfare
- Multi-Environmental Life Support Technologies
- Operational Medicine
- Platform Performance and Life Cycle Management

- Precision Weapons
- Radio Frequency Electronic Warfare
- Sensing (Air and Surface)
- Underwater Sensing and Countermeasures
- Weapons Effects and Countermeasures.

Expansion of International S&T Activities

We are enhancing our collaboration with our allies (particularly the U.S.) to facilitate interoperability and leverage additional knowledge and expertise. Access to advanced technologies from our allies is vital for Canada to maintain its defence capabilities and to be able to forecast long-term technology developments. We continue to benefit from international collaboration with Australia, New Zealand, the U.K. and the U.S. through The Co-operation Program, and with North Atlantic Treaty Organisation (NATO) nations as part of the NATO Research and Technology Organization. Other strategic international partners include the Netherlands, Sweden and France.

Enhanced Delivery of R&D Programs

DRDC operates five Defence Research Establishments (DRE):

- DRE Atlantic in Dartmouth, Nova Scotia, carries out R&D in undersea warfare and platforms;
- DRE Valcartier, outside Québec City, is the R&D centre for combat systems, surveillance and information systems;
- DRE Ottawa encompasses R&D electronics, radar, space systems and telecommunications;
- Defence and Civil Institute of Environment Medicine (DCIEM) in Toronto carries out R&D in human performance, simulation and training, military medicine and life support technologies; and
- DRE Suffield, near Medicine Hat, Alberta, is responsible for R&D in chemical and biological defence, military engineering and mobility systems.

We reorganized the R&D Program in 1995–96 into a collection of R&D "thrusts," consisting of projects that cut across technology lines, to meet the S&T requirements to support national defence capabilities. DRDC's advisory structure is based on a program management system to maximize the benefits of its relationships with its main client, the Canadian Forces. Based on five client groups (air, land, maritime, human factors, and command and control information systems), each element is guided by client R&D overview groups and advisory committees. With the launch of DRDC, two senior advisory levels have been formalized: the R&D Program Board endorses the plan for the program, while the R&D Advisory Board advises the Deputy Minister and Chief of the Defence Staff on strategic issues.

The Technology Demonstration Program was initiated in 1999 to provide opportunities for DRDC and partners from industry and other nations to collaborate on demonstrations of technologies. With funding of $30 million annually, technology demonstrations provide an effective means of evaluating the potential impact of technology and promote informed decisions on procurement. For example, the CB^{plus} Combat Duty Uniform for Broad Spectrum Toxic Hazard Protection will use emerging materials technologies to develop revolutionary new protective barrier and suit designs against chemical, biological, radiological and industrial hazards.

The Technology Investment Fund has become an important component of our innovation strategy. This program was initiated in 1998 to encourage research in high-risk, high-payoff technologies. Currently, 39 projects are in progress. For example, the "Hydrogen Storage in Carbon Nanotubes" project is evaluating the potential of carbon nanotubes to store large quantities of hydrogen in a stable form.

As part of its role to enhance the preparedness of the Canadian Forces by assessing technology trends, DRDC initiated a Technology Outlook Thrust to identify emerging technologies and assess their potential relevance to Canadian defence. Under this program, DRDC has sponsored joint symposiums on the "Revolution in Military Affairs" and "Concept Development and Experimentation." Studies on future trends in advanced power sources and biotechnology have been completed.

Leveraging the Benefits of National Partnerships

As part of the $90 million invested in partnerships and contracts with the private sector, the Defence Industrial Research Program is stimulating the S&T innovative capacity of small and medium-sized enterprises (SMEs) in the Canadian defence industry. With funding of $4 million annually, this program is a 50/50 cost-shared arrangement. Novel ideas from the private sector have been turned into value-added products and services. At the laboratory demonstration level, CO_2 Solutions

of Val-Belair, Quebec, has proven its unique biotechnological approach to the removal of carbon dioxide from enclosed spaces such as submarines. This technology has civilian applications as well, such as in carbon dioxide producing industries and sealed buildings, especially hospitals.

Building A National System of S&T for Defence Innovation

We are strengthening our system of S&T innovation with strategic national agreements with other government departments, including the National Research Council of Canada (NRC), Industry Canada/Technology Partnerships Canada, the Communications Research Centre, Health Canada and the Canadian Space Agency. The DRDC/NRC alliance is targeting R&D in information technology, vehicle technology and biological science. In addition, a collaborative research agreement between DCIEM and the Ottawa Heart Institute has been established to conduct R&D in operational medicine. Such research includes low-cost surgery, telemedicine, advanced medical imaging technology and patient simulation for training. These efforts are most effective in helping to focus our science capacity on the critical technologies needed to improve defensive measures and counters to emerging security threats of the future.

Contact Information

Science & Technology Policy
Defence Research and Development Canada
Tel.: (613) 992-7665
Web site: **http://www.drdc-rddc.dnd.ca**

DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE

Several programs of the Department of Foreign Affairs and International Trade (DFAIT) are highly implicated in international S&T, and provide critical support for the development of foreign and trade policy. Highlights are provided below.

Science and Technology Program

DFAIT's Science and Technology Program (**http://infoexport.gc.ca/science**) has been revitalized by the growing awareness that Canada's prosperity as an open trading nation depends on:

- access to international, leading-edge sources of knowledge;
- the development of key international markets through R&D strategic alliances; and
- the attraction of international investment and people for our domestic S&T-based industry.

Working as a facilitator on behalf of Canada's S&T community — companies, universities and science-based departments and agencies — the DFAIT S&T program helps to establish person-to-person contacts and networks that will help Canada's international R&D efforts take root and flourish. The program is delivered by Canada's network of Science and Technology Counsellors (S&TCs) located in Berlin, Brussels, London, Paris, Tokyo and Washington; Trade Commissioner Service Officers with S&T responsibility; and the Ottawa-based S&T division.

Existing S&T Agreements with France, Germany, Japan and the European Union (EU) provide official frameworks within which to discuss policy and research priorities, and to develop helpful administrative devices such as workshops, panels and sector coordination. Since 1998, in collaboration with the countries or regions concerned, the S&T program has coordinated eight full-fledged bilateral consultations, five of them in Canada.

In partnership with key national S&T organizations, DFAIT organizes R&D business and venture capital missions to strategic markets where excellence resides. These missions are often linked with international trade and technology fairs, or special S&T events. Since 1998, approximately 50 technology partnering events have been supported by the department's Science, Technology and Partnering Division. Through collaboration with the Industrial Research Assistance Program of the National Research Council, it also responds to specific requests by Canadian small and medium-sized enterprises (SMEs) to locate suitable R&D partners and sources of technology.

By cultivating relationships with the Canadian S&T community, and responding to their needs, DFAIT, through its international S&T network, provides S&T intelligence for the development of Canadian S&T policy and international R&D opportunities. Currently, a systematic approach to the management of strategic S&T intelligence information is being developed.

The annual S&TC tour organized by DFAIT rallies Canadian S&T interests and furnishes the personal contacts that can help the S&TCs enrich international R&D relationships. The counsellors and selected Trade Commissioner Service Officers

with S&T responsibilities travel across Canada to provide S&T briefings on their respective host countries and, likewise, are advised by Canadian researchers and officials on key issues and developments.

In promoting Canada as an advanced S&T country, missions abroad are assisted by new promotional materials, including a brochure featuring the broad range of Canadian S&T players and the unique partnership features of the Canadian S&T system.

Finally, mention should be made of the Going Global S&T Fund, which assists Canadians in establishing new international collaborative R&D initiatives. Since 2000, when this fund was consolidated, more than 20 initiatives have been supported, involving Japan, France, Germany, Taiwan, Singapore and the EU.

Technical Barriers and S&T-Based Trade Regulations

In the area of regulations, especially the science-based regulation of goods, DFAIT, through its Technical Barriers and Regulations Division (**http://www.dfait-maeci.gc.ca/tna-nac/menu-e.asp**), has actively supported the activities of other government departments, provincial authorities and the private sector. Its aim is to maintain or improve the market access of Canadian goods in foreign markets. Significant events over the last five years include:

- The conclusion of a package of multiple-sector Mutual Recognition Agreements (MRAs) with the Commission of the EU, Switzerland and the European Economic Area–European Free Trade Area countries of Iceland, Liechtenstein and Norway. The sectors covered include good manufacturing practices in pharmaceuticals, telecommunications terminal equipment, electromagnetic compatibility, medical devices, electrical safety (a provincial jurisdiction) and recreational craft. These MRAs provide for the mutual recognition of conformity-assessment activities carried out in the foreign jurisdiction to meet the domestic regulatory requirements.
- The successful challenging, through the World Trade Organization (WTO), of an EU regulation governing imports of hormone-treated beef and of an Australian regulation governing salmon imports. The WTO agreed that neither regulation was justified as they both lacked science-based risk assessment supporting a threat to health or safety.
- Support to the Canadian food biotechnology community against attempts to discriminate against Canadian food products, especially grains such as canola.
- Support to Natural Resources Canada to develop an international approach for the sustainable and safe use of metals and minerals, which included reliance on a study by the Royal Society of Canada on risk management with respect to the safe use of asbestos in building products.

These and other activities require a sustained and continuing discourse with scientists and engineers from the government and the non-government sectors alike.

Climate Change and Energy

Managed by its Climate Change and Energy Division, DFAIT has established the Clean Development Mechanism and Joint Implementation Office (**http://www.dfait-maeci.gc.ca/cdm-ji/menu-e.asp**), to address climate change in line with Canada's commitments to the Kyoto Protocol. The office facilitates Canadian participation in international projects supported by these two funding mechanisms, whose objective is to reduce global greenhouse gas (GHG) emissions while supporting sustainable development. Along with strengthening Canadian capability to develop, register and implement emissions-reduction or sequestration projects internationally, the office assists with the penetration of Canadian companies in new markets; the transfer of Canadian technologies; and business expansion of Canadian environmental services companies, leading to significant GHG reductions in the future.

The International Policy and Related Activities component of the Climate Change Action Fund includes work on emissions inventory methods, monitoring and reporting to assist Canada in meeting its international reporting obligations on GHG inventories, leading to future GHG reductions. A portion of this money is used by DFAIT's Climate Change Division for its efforts in negotiations, which will lead to greater demand for climate change technologies.

Collaborating with Natural Resources Canada and Industry Canada, which lead the Canadian International Technology Initiative, DFAIT helps to develop climate change technology transfer projects overseas, facilitate market opportunities for Canadian companies and build a base for future international technology marketing activities. The initiative includes posting

Climate Change Technology Promotion Officers at DFAIT missions abroad.

Aboriginal and Circumpolar Affairs

Under the Northern Dimension of Canada's Foreign Policy (NDFP) (**http://www.dfait-maeci.gc.ca/circumpolar/main-e.asp**), announced in June 2000, Canada has committed $2 million a year until 2004–2005 to promote Canadian interests and values as we work with other circumpolar countries to address the unique challenges of the North. Among the important assets Canada brings to the circumpolar table is an acknowledged expertise in northern science and environmental technology, and a cutting-edge capability in telecommunications and information technology.

One of the main priorities of the NDFP is strengthening and promoting the Arctic Council as the principal forum for circumpolar cooperation. DFAIT's Aboriginal and Circumpolar Affairs Division administers funding and contributes to the placement of expertise on a range of Arctic Council working group projects related to S&T. (See **http://www.dfait-maeci.gc.ca/circumpolar/arcticcncil-e.asp** for details.)

DFAIT supports other initiatives that advance international cooperation in circumpolar S&T, such as Arctic Science Summit Week, the Arctic-Antarctic Research Program and topical seminars for enhancing international S&T collaboration among circumpolar experts. For example, "A Common Approach to Collaborative Technological Research for Arctic Development," a workshop sponsored by the EU, Canada, Russia and the U.S. (Brussels, October 2001), brought together Arctic experts in Earth observation, climate change, transportation, environmental management, telecommunications and Arctic research infrastructure. This workshop will serve as a springboard for future cooperation in circumpolar S&T.

Contact Information

Department of Foreign Affairs and International Trade
Tel.: (613) 992-7023
Web site: **http://infoexport.gc.ca/science**

ENVIRONMENT CANADA

Guided by the 1996 federal S&T strategy, Environment Canada (EC) has taken many important steps over the last five years to ensure the ongoing excellence of its S&T. This annex highlights how EC's S&T governance mechanisms have evolved and then reviews major strategic S&T management activities and how these address the seven principles of the strategy.

Creating New Institutions and Mechanisms for Governance

Following the 1996 strategy, EC revised its existing departmental S&T management committees and also created new bodies. The former S&T management committee was restructured into two groups: an Assistant Deputy Minister-level S&T Executive Committee and a Director General/Director-level S&T Management Committee. A new external S&T Advisory Board was established in 1997 to provide external advice to the Deputy Minister on issues associated with S&T. An evaluation of the performance of the S&T Advisory Board was undertaken in 1999, which led to some changes in the board's operations. Two members of the S&T Advisory Board serve on the Council of Science and Technology Advisors (CSTA). A Special Science Advisor to the Deputy has also been appointed.

These groups and individuals constitute the EC S&T Management System. It addresses common issues and shares best practices across the department. This system is also EC's principal means for both contributing to the development of, and advising on, the implementation of federal S&T policies and improved management practices.

Acting on the advice of the S&T Advisory Board, the Nature, Clean Environment, and Weather and Environmental Prediction business lines each developed a research agenda for the period 2000–2005. These agendas will be combined into an integrated departmental research agenda. Its development is helping EC to better articulate its R&D capabilities and capacity to meet emerging challenges.

Working in collaboration with other science-based departments, EC is leading the development of a proposal for a new way to manage and fund collective action on emerging S&T-based national issues. The Federal Innovation Networks of Excellence is aimed at integrating the S&T resources of federal departments, universities and the private sector to provide solutions to emerging crosscutting national policy issues and to seize economic opportunities for the public good.

Operating Principles for S&T Policies and Programs

Increasing the Effectiveness of Federally Supported Research

The effective use of science advice in making policy and regulatory decisions is a high priority for EC. Upon the release of the CSTA's *Science Advice for Government Effectiveness* report, EC assessed its science advice practices against the principles and guidelines outlined in the report. Overall, EC has been successful in incorporating science considerations into its planning and decision-making processes. Improvements were identified to foster and enhance its policy and regulatory decision making based on sound science advice.

EC developed a three-year plan to guide the implementation of the Framework for S&T Advice, which focusses on two key challenges: strengthening the existing science advisory practices to ensure they reflect the principles and guidelines of the framework, and addressing the gaps that were identified.

In 2000, EC engaged its S&T community in a discussion of values and ethics focussed on what it means to be a scientist in the department. A cross-country series of case-driven workshops resulted in seven recommendations, including the development of an orientation program and the appointment of a departmental champion for values and ethics. Work is currently under way to implement these recommendations.

The National Water Research Institute (NWRI) has developed and published a core competency framework to develop its science managers and aid in hiring new staff. The institute also assessed its management practices against the attributes of a well-managed research organization developed by the Office of the Auditor General. The assessment indicated that overall research at the NWRI is extremely well-managed.

The Meteorological Service of Canada (MSC) is undertaking an international peer review of its R&D programs to examine their scientific excellence, organizational relevance, and the impacts of their results on services, policies and knowledge creation.

The Canadian Wildlife Service (CWS) created a Wildlife Research Task Force to provide advice on activities and the direction needed to maintain its national and regional research centres as leaders in wildlife and biodiversity science in Canada and internationally. The task force is preparing a series of reports to clarify the CWS science agenda to ensure that science undertaken by the CWS and its close partners forms an effective basis for decision making.

Capturing the Benefits of Partnerships

S&T linkages with the broader environmental S&T community, both in Canada and internationally, are critical to EC's ability to deliver and make effective use of S&T. EC is exploring the development of a hub for environmental science networks in Canada — the Canadian Environmental Sciences Network. This network is envisaged as a vehicle to link regional and issue-specific networks, as well as users and providers of scientific information about the environment. It may also serve to report on crosscutting environmental issues and to develop an environmental sciences agenda for Canada.

The department has had success with targeted national and regional environmental science networks such as the Climate Research Network, the Canadian Cooperative Wildlife Health Centre, the Wildlife Ecology Research Chair at Simon Fraser University, and the Atlantic Cooperative Wildlife Ecology Research Network. New networks focussing on wildlife and water-research issues are already being developed, while the MSC has developed additional atmospheric networks, including the Canadian Weather Research Program and the Air Quality Research Network. The MSC is also involved in numerous international partnerships, including the North American Research Strategy on Troposphere Ozone.

The MSC is involved in numerous partnerships for research and for delivering its science-based programs to Canadians. The Environmental Protection Service is strengthening its 30-year partnership arrangement with provincial, territorial and regional jurisdictions via a new memorandum of understanding for the National Air Pollution Surveillance Network.

The CWS Strategic Plan 2000 called for strengthened wildlife science capacity and new strategic liaisons with universities for the study of applied conservation concerns. In response, the National Wildlife Research Centre (NWRC) has renewed much of its aging equipment and instrumentation, and begun construction of its new building on the Carleton University campus to formalize that partnership and form the hub for the expansion of the Wildlife Science Network across Canada. The CWS, led by its Atlantic Region office, also organized a workshop to assess existing research partnerships and opportunities for enhancement.

EC, along with the Canadian Meteorological and Oceanographic Society, was instrumental in establishing the Canadian Foundation for Climate and Atmospheric Sciences in February 2000. The goal of the foundation is to foster research on climate systems, climate change, extreme weather, air quality and marine environmental prediction. The foundation is an independent research foundation whose activities involve Canadian universities, federal government departments and the private sector; its operation is based very much on cooperative partnerships. The initial award to the Foundation was $60 million over six years. EC is represented on the board of the foundation, on its Grant Review Committee, and as a partner in many of the research projects.

Emphasizing Preventive Approaches and Sustainable Development

EC works collaboratively with Agriculture and Agri-Food Canada, Fisheries and Oceans Canada, Health Canada and Natural Resources Canada on Science for Sustainable Development under the 5NR MOU. The 5NR gives a collective focus to the member departments' mandates in an effort to protect the long-term health and diversity of all species, promote energy efficiency and clean technologies, and wisely manage and conserve renewable resources. The department also works collaboratively with industry and academia in the development, evaluation and demonstration of clean technologies.

Positioning Canada Competitively Within Emerging International Regulatory, Standards and Intellectual Property Regimes

Canada is an active participant, and often a leader, in the broad range of international science-based agreements to prevent harm to the global environment. These agreements include the preservation of the stratospheric ozone layer, the protection of endangered species, the conservation of biodiversity and its companion protocol on bio-safety. Two more recent and as yet unratified agreements affecting the environment are of high interest to Canada: the Kyoto Protocol on climate change, designed to manage greenhouse gas emissions, and the treaty directed toward banning certain persistent organic pollutants.

Building Information Networks

Access to better knowledge and information on environmental issues is critical to achieving a more integrated approach to environmental decision making. The Task Force on the Canadian Information System for the Environment was created to strengthen the management and sharing of environmental information as the basis for sound public policy on the environment and as a foundation for government accountability.

Extending S&T Linkages Internationally

One of the greatest sources of new ideas and emerging technologies affecting S&T in Canada is the world beyond our boundaries. EC is actively involved in international bodies. The MSC, for example, represents Canada on the councils of the World Meteorological Organization, the Intergovernmental Panel on Climate Change and the Inter-American Institute for Global Change Research. The MSC is also the lead agency for the Arctic Climate Impacts Assessment. The Environmental Protection Service participates in many international organizations that set scientific standards relating to environmental protection such as the International Standards Organisation and the Organisation for Economic Co-operation and Development (OECD).

The Canadian Biodiversity Information Network is the Canadian node on the international clearing house mechanism of the United Nations Convention on Biological Diversity, and contains biodiversity information and data from across the country.

Promoting a Stronger Science Culture

EC has been a leader in promoting science communications. At the national level, EC's communication teams have developed four diverse products to bring S&T to Canadians. Using different media, they are targeted to both general and specialized audiences, and include the news media as a message multiplier. (Each product is available on the Green Lane, Environment Canada's Web site, at **http://www.ec.gc.ca**) The materials produced nationally are tracked based on their media pickup.

The EC S&T Advisory Board has focussed on science communications as a priority area for advice to the department. They developed a Science Communications Framework and concluded there was a "need to make popular communications a high priority."

In 1998, EC developed a ground-breaking pilot training course for a dozen up-and-coming scientists with an interest and aptitude for communications. Communications personnel

from across EC were also fully involved to build linkages between the two constituencies.

Building on concepts developed by EC, further pilot courses in risk communication media training were developed cooperatively by a group of federal science departments in early 2001. The courses were intended as a basis for a coordinated training program. Also, in collaboration with other federal natural resource departments, EC has taken a leadership role in a partnership with the (Canadian) Discovery Channel to produce "Earthtones," a series of vignettes showcasing science activities. These can be accessed at **http://www.durable.gc.ca/radio-video/video/index_e.phtml**

Contact Information

Science Policy Branch
Environment Canada
Tel.: (819) 994-5434
Web site: **http://www.ec.gc.ca/scitech**

FISHERIES AND OCEANS CANADA

The Department of Fisheries and Oceans (DFO) Strategic Plan, *Moving Forward with Confidence and Credibility*, and the *Scientific Strategic Plan for Fisheries and Oceans Canada: Setting the Course for the New Millennium* have provided the recent direction for the continuing implementation of the 1996 federal S&T strategy.

In recent years, the department has made significant progress on all aspects of S&T management as set out in the strategy, especially with respect to priority-setting and addressing mandated activities. The governance of S&T has been improved through a greater role of external advice and the continuing work of DFO's Science Advisory Council (SAC), with the further integration of performance measures and more effective interdepartmental coordination. These programs and activities have been supported by strategic alliances and collaborative arrangements, and have been aimed at excellence in S&T and the strengthening of research capacity in Canadian universities, federal laboratories and institutions. DFO programs, established on the principles outlined in the strategy, address the department's responsibilities for sustainable development, the precautionary approach, ecosystem management, collaborative R&D and the enhancement of Canada's knowledge infrastructure. The following examples illustrate DFO's implementation of the strategy.

Partnerships

DFO has increased the effectiveness of S&T programs through the leveraging of funding opportunities, enhanced knowledge transfer and technology development, increased collaboration and cooperation, and through the commercialization of science. A good example is the Ocean Monitoring Workstation project. In preparation for the operational maritime use of Synthetic Aperture Radar sensor data from the Canadian RADARSAT-1 satellite, DFO and Natural Resources Canada (NRCan) established a committee to identify marine applications.

This development and demonstration project, which uses RADARSAT data, was undertaken with funding provided by DFO, NRCan, the Department of National Defence, Transport Canada, the Canadian Space Agency and Environment Canada. Satlantic Inc., a company located in Atlantic Canada, now services and markets the Ocean Monitoring Workstation to a growing community of national and international users. In 2000, Satlantic Inc. received an Industry Canada award for technology product innovation. DFO is evaluating the operational use of RADARSAT and future satellite data as part of its fisheries surveillance information program.

DFO continues to make significant progress through its expanded partnerships, strategic alliances and collaborative arrangements. For example, DFO has launched, and participates in, an academic partnering program that has seen the creation of seven academic research chairs. The program includes an academic subvention component, wherein research grants and scholarship supplements are given to academics involved in research that meets DFO S&T priorities. In 2001–2002, DFO funded the first round of R&D projects under its Aquaculture Collaborative Research and Development Program, a program that was created and funded to perform collaborative R&D with industry in support of sustainable aquaculture.

S&T Advice

The Canadian Science Advisory Secretariat (CSAS) coordinates the peer review of scientific information and advice for decisions on resource management at DFO (e.g. fish management plans). The different regions of the department conduct their resource assessment reviews independently, tailored to regional characteristics and stakeholder needs. CSAS facilitates these regional processes, ensuring national standards of

excellence and continuing improvements for methodology, interpretation and advice. CSAS works with the regions to develop integrated overviews of issues in fish stock dynamics, ocean ecology and the sustainable use of living aquatic resources, and to identify emerging issues to be addressed.

CSAS also coordinates the communication of the results of the scientific review and advisory processes. Reports on the status of fish, invertebrate and marine mammal stocks, environmental and ecosystem overviews, research documents featuring detailed scientific information, and proceedings of peer review meetings are available from CSAS or can be downloaded from the DFO Web site (**http://www.dfo-mpo.gc.ca/csas/csas/english/index_e.htm**).

SAC advises on strategic directions for S&T within the department and on ways to collaborate with the private sector, universities and provincial governments. SAC participated in the development of DFO's Science Strategic Plan, and it continues to review and advise on the direction, balance and relevance of DFO's S&T priorities and programs to meet the department's conservation mandate and the needs of its clients from both national and regional perspectives.

To further refine the department's science advice practices and processes, DFO has developed a performance measurement framework, based on the principles and guidelines contained in the *Framework for Science and Technology Advice*. Annual performance measurement reports will be used to systematically assess the impact of science in decision making on a case-by-case basis.

DFO continues to promote the Performance Measurement Framework within the department and works with colleagues in other science-based departments and agencies to collectively address the implementation of the framework through interdepartmental initiatives.

Research

To investigate the effects of climate change and northern industrial development on the Arctic ecosystem and food chain, several DFO biologists spent the last two years studying the behaviour and movements of ringed seals in Canada's western Arctic. The study provided important new information about the behaviour of seals as they move between the ice-free and ice-covered waters of the Beaufort Sea. The tagging data showed that the Viscount Melville Sound area, some 800–1000 km away, was their destination. After feeding there for some weeks, the adult seals then returned to the waters off Holman Island, very close to where they were tagged. This migratory pattern has never before been documented. Continued research on this important species will play a role in our preparedness for renewed oil and gas exploration initiatives in the western Arctic. The work was funded by DFO, the Fisheries Joint Management Committee and, in 1999, by the World Wildlife Fund (Canada) (WWF).

International Collaboration

The Recovery Plan for the endangered North Atlantic right whale is an example of DFO's collaborative international research. The North Atlantic right whale is currently estimated to have a total population of only 300. DFO has launched a number of initiatives to recover the population of the whale and to reduce further threats to its numbers from human activities:

- In 1993, two areas — Grand Manan Basin in the Bay of Fundy and Roseway Basin on the Scotian Shelf — were identified as critical habitat for right whales.
- The department, in collaboration with the WWF, the East Coast Ecosystem and other partners, has embarked on an educational and outreach program to target one of the principal threats to the species — commercial ship traffic. The Canadian Coast Guard provides advance warning of the presence of endangered whales to mariners entering Bay of Fundy waters and advises on measures that should be taken to avoid collision. With the cooperation of the Atlantic Pilotage Authority, information in the form of a brochure is distributed to most vessels entering or departing Atlantic Canadian ports. Information has also been provided to the fishing industry on the endangered status of these whales.
- To gain more data on the species, whale-sighting information is collected from research vessels, aircraft, whale watchers and from industry. This information is collected and compiled in collaboration with U.S. researchers and is provided in an effort to further protect this endangered species.

Hydroacoustics is another S&T area in which DFO is involved in international collaborative research. A DFO team, led by scientists from the Maurice-Lamontagne Institute in Mont-Joli, Quebec, has developed versatile hydroacoustic software packages referred to as CH1 and CH2, to collect, archive and process multi-channel multi-echo sounder hydroacoustic data. They are based on a new format, called the HAC format.

Along with American and French colleagues, the team is creating high-resolution data produced by various types of echo sounders, as well as the auxiliary information required for its proper interpretation under the new HAC format. This format was officially adopted by the International Council for the Exploration of the Sea in 1999, as the common data format for exchanging fisheries acoustics data and for comparing processing algorithms. It responds to the needs of various research organizations around the world for constructing self-contained multi-channel hydroacoustic data banks.

Contact Information

Program Planning and Coordination, Science Sector
Fisheries and Oceans Canada
Tel.: (613) 990-0227
Web site: **http://www.dfo-mpo.gc.ca**

HEALTH CANADA

Health Canada is the federal department responsible for helping the people of Canada maintain and improve their health. The department works in partnership with provincial and territorial departments, and collaborates with other federal departments and agencies, international organizations, and stakeholders to achieve its mandate. Areas of responsibility directly relevant to S&T include the management of risk to health from diseases and products (food, water, drugs, medical and radiation-emitting devices, natural health products, pest control products and consumer products) and research into the determinants of health and population health.

In 2000, two major developments had significant impacts on the way science is managed and conducted: Health Canada's realignment and the repositioning of health research in Canada.

Health Canada Realignment

Health Canada's realignment was initiated to meet the challenges of the 21st century: advances in health knowledge and technology; changing public expectations; and an increasing need for partnership, collaboration and horizontality. The department had established a Science Advisory Board in 1997 and in June of 1999, opened the Canadian Science Centre for Human and Animal Health in Winnipeg, the first facility in the world combining human- and animal-health disease research. The facility is jointly operated by Health Canada and the Canadian Food Inspection Agency, and incorporates Level 2, 3 and 4 laboratories.

In the realigned department, health promotion and community action have been integrated with health surveillance and disease prevention and control. Also, program focus has been improved, science capacity has been increased, and more emphasis has been put on effective horizontal management and accountability.

Prior to 2000, Health Canada had one major science-based branch, the Health Protection Branch. Now it has three: the Health Products and Food Branch, the Healthy Environments and Consumer Safety Branch, and the Population and Public Health Branch with its National Microbiology Laboratory in the Science Centre in Winnipeg. In addition, science activities are being conducted in the Pest Management Regulatory Agency (PMRA), the First Nations and Inuit Health Branch (FNIHB), and the Health Policy and Communications Branch.

Realignment also resulted in the creation of the Office of the Chief Scientist, bringing greater leadership, coherence and expertise to the overall strategic direction of the department's scientific responsibilities, activities and needs.

Repositioning Health Research in Canada

In Canada, health research is conducted mainly by the private sector, academia and voluntary organizations. Health Canada conducts a small ($58 million in 2000–2001) but important part of this research, in addition to its related scientific activities ($187 million in 2000–2001) such as surveillance and risk assessment. The department's S&T activities are key to health policy and regulatory developments.

The 1999 federal budget and Speech from the Throne laid the groundwork for repositioning health research. Health Canada played an important role in the creation of the Canadian Institutes of Health Research (CIHR), and collaborations between the two organizations are continuously being strengthened. June 2000 saw the establishment of the Health Research Secretariat, a focal point for connecting with the agencies and organizations that generate health research.

The Federal S&T Principles and Health

In addition to the organizational changes mentioned above, Health Canada can report several key accomplishments that support federal S&T principles. The following information highlights only some of the numerous achievements of the department.

- Health Canada recruited internationally renowned scientists into several lead scientific positions through the Interchange Canada Program. The department is fostering scientific excellence, focussing work on specific strategic science goals, bringing several targeted areas of science to the "cutting edge," training staff in enhanced areas of expertise, initiating new collaborations with national and international partners, improving linkages with universities, and recruiting in critical gaps areas.
- By capitalizing on extensive in-house experience, Health Canada established a credible research initiative in proteomics as part of the larger Ottawa Proteomics Consortium, involving scientists from government, academia and other health research institutes. The current research direction couples proteomic analysis with functional genomics and pharmacogenomics to better assess the causes of disease and the effects of therapeutic interventions.
- The Centre for Surveillance Coordination is building federal/provincial/territorial networks of people, tools and information to address key capacity gaps in health surveillance across Canada. The Laboratory for Foodborne Zoonoses has completed several pilot projects and feasibility studies under the Canadian Integrated Public Health Surveillance program, linking animal/food data from provincial partners to federal public health data.
- The Centres of Excellence for Children's Well-Being Program ($20 million over five years) is creating national networks of expertise, supported by information technology, to consolidate leading-edge research about the physical and mental health needs of children.
- The FNIHB continues to support First Nations communities in identifying research priorities and making research results more relevant to the communities. Partnerships with CIHR, in particular the Institute for Aboriginal People's Health and the Canadian Population Health Initiative, ensure that research is relevant and is effectively translated into policy and program development.
- The PMRA, working closely with the U.S. and Mexico under the North American Free Trade Agreement (NAFTA) Technical Working Group on Pesticides, has developed joint review processes for pesticides. The first category was for reduced-risk chemical pesticides followed by pesticides with microbial or an arthropod semiochemical (including pheromones) as active ingredients. More recently, the programs have been expanded to cover all new pesticides, as well as second entry products. Joint reviews increase the efficiency of the registration process, facilitate simultaneous registration and increase access to new management tools in all three countries.
- International efforts of Health Canada's Food Directorate aim towards the harmonization of approaches for assessing the safety of foods derived from biotechnology and the development of new and improved tools for conducting these assessments. The directorate is involved in the Organisation for Economic Co-operation and Development (OECD) Task Force on the Safety of Novel Foods and Feeds, the recent Joint FAO/WHO (Food and Agriculture Organization of the United Nations/World Health Organization) Expert Consultations on Foods Derived from Biotechnology, and the program of work of the Codex Ad Hoc Intergovernmental Task Force on Foods Derived from Biotechnology.
- Federal responsibility for food safety is shared between Health Canada and the Canadian Food Inspection Agency. This collaboration ensured that the impact of the Belgian Dioxin Crisis in 1999 was kept under control and that foods of Belgian origin sold in Canada posed no health risk. The department's risk assessments made use of results of a recent WHO review in which a Health Canada scientist had actively participated.
- The Climate Change and Health Office has established its first Research Agenda, following the 2001 National Science and Policy Research Consensus Conference, as well as eight interdisciplinary extramural Health Issue Research Networks, coordinated by research partners at universities and non-governmental organizations.
- Under the 5NR MOU on Science and Technology for Sustainable Development, a National Agenda on the Scientific Assessment of Endocrine Disrupting Substances in the Canadian Environment was established, and a workshop lead by Health Canada resulted in the publication of *Our Children, Our Health: Towards a Federal Agenda on Children's Environmental Health*.
- In 2000, the Action Plan for Urban Use Pesticides was developed by PMRA. The action plan focusses on three broad areas: priority re-evaluations of the seven most commonly used lawn care pesticides; increased emphasis on the review of reduced-risk new pesticides; and, in collaboration with provincial and territorial governments, the implementation of

a Healthy Lawns Strategy that is intended to reduce reliance on pesticides registered for domestic uses, with emphasis on non-chemical means of controlling pests.

- Canada, as represented by the Biologics and Genetic Therapies (BGTD) and Therapeutic Products directorates, is the only observer country to the International Conference on Harmonization, the most important harmonization initiative in the area of therapeutic product regulation. The department has contributed significantly to the development of over 45 harmonized technical guidelines.
- The BGTD developed a method to determine the safety of pertussis vaccine products that is being used in an international collaborative study assessing an international standard for pertussis toxin. It is also being assessed in a European Pharmacopoeia collaborative study as an alternative methodology for pertussis toxin testing. This new method replaces several empirical safety tests, including animal tests.
- Under the National Diabetes Surveillance System (NDSS) established in 1999, software was developed that is currently being implemented in eight of the provinces and the three territories. The NDSS addresses the critical information gaps regarding diabetes in Canada. It will enable the long-term monitoring of diabetes by facilitating ongoing surveillance, including the creation and dissemination of national comparable information to assist in effective prevention and treatment strategies.
- The FNIHB has developed international linkages related to research on indigenous populations through the International Union of Health Promotion and Education, and through discussions with the Institute for Aboriginal People's Health at CIHR, to strengthen key contacts in New Zealand and Australia.

Contact Information

Office of Biotechnology and Science
Health Canada
Tel.: (613) 957-6432
Web site: **http://hc-sc.gc.ca/**

INDUSTRY CANADA

The 1996 federal S&T strategy reaffirmed the Minister of Industry's mandated responsibility for horizontal S&T policy coordination across the government. This responsibility is in addition to authority over the 15 departments and agencies within the Industry Portfolio. Industry Canada is central to this mandate, having an internal S&T capacity and a policy role, and by acting as a funder and enabler for S&T activities. Industry Canada's mandate is to make Canada more competitive by fostering the growth of Canadian business; promoting a fair, efficient marketplace; and encouraging scientific research and technology diffusion. Many of the programs described below focus on the creation and deployment of knowledge, often through S&T. Although Industry Canada's activities help Canada to move towards all three of the strategy's goals, its major contributions are in the areas of sustainable wealth and job creation, and the advancement of knowledge.

The Communications Research Centre (CRC), as a principal federal research centre in telecommunications, has become an instrument for creating competitiveness through new innovative R&D programs, and for providing a greater focus on the diffusion of new technologies and knowledge.

The CRC, in collaboration with Canadian industry and the European Eureka 147 project, developed an international standard for digital audio broadcasting (DAB), suitable for Canada. Commercial DAB service was launched in 1999 and now reaches 40 percent of Canadians. Canada is the only country in the Americas where a commercial DAB service is available. Because DAB is also able to simultaneously provide data services such as Intelligent Highway System services, a major car manufacturer in Canada is now equipping its new vehicles with it.

The CRC played a key role in the development of the North American digital television (DTV) system, including high definition television (HDTV), through testing and evaluating the picture quality of the proposed systems. The standard was adopted in Canada in 1997. The broadcasting industry, with the technical support of the CRC, is currently conducting field trials of the system in Ottawa and Toronto. CRC has also developed a DTV-compatible 3D (stereoscopic) television system, which will provide Canadian television broadcasters with new service opportunities. The system was demonstrated over the field trial transmitter in Ottawa. Over-the-air 3D television transmission is a world first.

Technology Partnerships Canada (TPC) is a special operating agency of Industry Canada. As such, it contributes to achieving the department's strategic objectives to encourage R&D and high technology projects in Canada. TPC's operations directly support Industry Canada's key objectives. TPC was

created in 1996 to address the needs of established companies in specific industrial segments, to ensure that Canadian firms became more innovative. TPC advances and supports government initiatives by investing strategically in research, development and innovation to encourage private sector investment, and to maintain and grow the technology base and technological capabilities of Canadian industry. TPC also encourages the development of small and medium-sized enterprises (SMEs) in all regions of Canada. TPC expenditures reached $250 million annually by 1999. As of June 30, 2001, TPC's portfolio included 130 investments totalling $1.6 billion, which will leverage $7.4 billion in innovation spending. TPC is helping to spur innovation in emerging areas such as biotechnology, information and communications technologies, eco-efficient technologies, and leading-edge technologies in aerospace and defence. TPC's investments, if successful, are forecasted to create or maintain 30 441 jobs. Also, TPC investments are driving an unprecedented wave of new R&D and innovation — cornerstones of our quality of life.

Genome Canada, a not-for-profit corporation, has received $300 million in grants from the federal government, through Industry Canada, to support a national genomics research initiative for the benefit of Canadians. Five research centres (chosen through a competitive process) are being established in regions across Canada.

Industry Canada, through its focus on building the knowledge-based economy, has been a key supporter of the Precompetitive Applied Research Network (PRECARN) in Phases I and II, and will continue in Phase III. PRECARN is a national, industry-led R&D consortium whose purpose is to develop intelligent-systems solutions to real industry needs supported by world-class, leading-edge university-based research. Technologies supported are robotics, machine sensing, human-machine interface and intelligent computation.

PRECARN funds, coordinates and promotes collaborative research conducted by industry, university and government researchers. With support from Industry Canada (approximately $70 million over ten years), other federal departments and provincial government agencies, PRECARN plays a key role in Canada's growing intelligent systems sector.

The Canada Foundation for Innovation (CFI) was established in 1997 to award funds to universities, research hospitals and not-for-profit institutions to modernize their research infrastructure and equip themselves for state-of-the-art research. Industry Canada provides policy advice on the management and operation of the CFI, and the Minister is accountable to Parliament for the foundation. The department will continue to support the CFI in this capacity. In addition, in cooperation with the CFI and the granting councils, it will help in meeting infrastructure needs identified by the Canada Research Chairs.

The Canadian Intellectual Property Office (CIPO) has fully automated its patent and trademark systems, and is currently automating its industrial design process. The implemented systems are TECHSOURCE and INTREPID II for patents and trademarks, respectively. The automation of these internal systems has allowed CIPO to offer a vast number of on-line electronic services to clients via Web-enabled patent and trademark databases. CIPO's on-line services allow clients to perform a multitude of tasks, including searching Web-enabled patent and trademark databases, filing applications, paying fees and ordering copies of official documents in a secure environment. Additionally, the Web site publishes official records and journals, and disseminates general information about intellectual property, examination processes and filing procedures to obtain intellectual property protection.

Technology Roadmapping, an industry-led planning process driven by the projected requirements of tomorrow's markets, helps companies identify, select and develop technology alternatives to satisfy future service, product and operational needs.

Industry Canada is the catalyst helping to bring together qualified industry representatives and other specialists to develop evolving roadmaps that identify the challenges and develop frameworks for making appropriate and timely technology decisions.

Industry Canada also plays a central role in realizing the government's Connecting Canadians vision — a strategy to make the information and knowledge infrastructure accessible to all Canadians. Since 1995, Canada has become recognized as a world leader in connectivity. Industry Canada has supported and/or implemented the following initiatives:

- connected all public schools and libraries to the Internet;
- connected 10 000 voluntary organizations to the Internet;
- delivered about 300 000 computers to schools;

- created CA*net 3, the world's fastest research Internet backbone;
- launched 12 Smart Community sites across Canada;
- launched the geographic lane on the Internet through GeoConnections; and
- provided Canadians with affordable public Internet access at 8800 sites.

Industry Canada has also been an important leader in developing content for Canada's information highway through programs such as SchoolNet and Digital Collections.

Contact Information

S&T Strategy Directorate
Industry Canada
Tel.: (613) 993-7589
Web site: **http://strategis.gc.ca**

NATIONAL RESEARCH COUNCIL OF CANADA

When the National Research Council of Canada (NRC) launched its Vision four years ago, it charted a new course to the future, one that would integrate our traditions and strengths in R&D with new opportunities to build Canada's innovation capacity. Over this period NRC has undergone a fundamental transformation to a knowledge and innovation organization — one that generates new knowledge through leading-edge research, creates new enterprises to commercialize the results of that work and fosters the growth of technology clusters across Canada.

With 17 research institutes and an Industrial Research Assistance Program (IRAP) presence in 90 communities across the country, NRC has delivered regional initiatives; built technology clusters; advanced scientific and technical knowledge; discovered ways to deliver more information faster and more efficiently; spun-off companies; and targeted emerging research areas such as genomics, fuel cells and advanced photonics. Below are only a few of the major achievements realized that illustrate this transformation.

Major Achievements

NRC is an active partner in Canada's S&T community with close to 1000 collaborative agreements, of which more than half are with industrial partners and one third are with international partners from around the globe.

NRC is first and foremost a scientific and technical organization. Over the period of the Vision, the number of NRC publications has increased from 2026 to 2824. And to top it off, many NRC scientists and engineers have been awarded with fellowships and medals of the Royal Society of Canada; two were appointed to the Order of Canada; and two researchers won an Academy Award for film animation.

Regional Initiatives and Technology Clusters

Ottawa (information communications technologies, photonics), Saskatoon (agri-biotechnology) and Montréal (aerospace, biopharmaceutical, materials) have become synonyms for the successes of NRC's technology cluster model. In 1999–2000, NRC launched four additional regional technology clusters in Atlantic Canada (Halifax, St. John's, Cape Breton and New Brunswick). These initiatives will strengthen Atlantic Canada's innovation capacity from life sciences to information technology. Ottawa and Montréal are now part of the $68-million Aerospace Technology Infrastructure Initiative, announced in October 2000 by Prime Minister Jean Chrétien.

Biotechnology Group

NRC's Institute for Biodiagnostics enhances Canada's capacity in medical imaging technologies. So far, the Institute has made important advances such as fluorescent imaging for open-heart surgery and has spun-off three companies.

The Biotechnology Research Institute has launched the Montréal Centre of Excellence for Environmental Site Remediation, along with local partners. Dr. Harold Jennings of the Institute for Biological Sciences in Ottawa, developed a vaccine for infant meningitis after 25 years of research. This vaccine has already been licensed in the United Kingdom and is soon to be released in Canada.

The Plant Biotechnology Institute, in collaboration with the Saskatchewan Wheat Pool, successfully developed a new strain of high-yield wheat variety called McKenzie. In 1999–2000, introductory sales of seed volumes for this variety of wheat exceeded the amount needed to plant more than 500 000 acres in Canada and the United States.

NRC's Genomics and Health Initiative, introduced in 1999, will achieve key results in genome sequencing, proteomics, cancer treatment and plant genomics.

Manufacturing Technologies Group

During the past five years, the Manufacturing Technologies Group (MTG) took a number of steps to better serve the needs of Canadian manufacturers. In partnership with the Natural Sciences and Engineering Research Council of Canada and Natural Resources Canada, it launched the National Fuel Research and Innovation Initiative. With the emergence of Vancouver as the leading centre worldwide for fuel cells, NRC has established the Fuel Cells Technologies Centre to support innovative start-up companies and to serve as the focal point for fuel cell system innovation.

In 1999–2000, the MTG collaborated with the Canadian manufacturing industry to complete a major strategic planning exercise aimed at enhancing the industry's innovative capabilities and fostering collaboration between research and industry. The strategic plan identified four priorities for the MTG and industry: nanotechnology, virtual manufacturing, the expanding role of the Internet in manufacturing, and the need for widespread engagement of the manufacturing sector in setting the innovation agenda.

Information and Communications Technologies Group

NRC's Institute for Microstructural Sciences (IMS) has produced significant research results that will increase our understanding of the optical properties of quantum dots. IMS co-manages the Canada Europe Research Initiative on Nanostructures network of 17 European and eight Canadian nodes that are actively participating in similar research on nanoelectronics, nano-optics and advanced nanostructures. Nanotechnology will be of critical importance to the semiconductor and microelectronics sectors as the physical limits of current technologies are reached.

In 1999–2000, NRC's Institute for Information Technology joined the international Civilian American and European Surface Anthropometry Resource project. This project, which has involved thousands of people, will generate information on the design and development requirements of the member companies for cars, garments, safety equipment and other applications.

IRAP: Expanding Connections for SMEs

IRAP plays a fundamental role in the development of Canada's industrial innovation capacity of small and medium-sized enterprises (SMEs). IRAP has developed and will continue to further expand its connections to benefit Canadian SMEs. IRAP helps close to 12 000 firms and attracts an average of 3000 new clients each year.

IRAP launched the Canadian Technology Network (CTN) in 1996, a network where industry associations, SMEs, universities and government can interact by building networks and expertise. The CTN has increased its membership from 300 to more than 1000 members, and it answers close to 3000 queries per year. IRAP has also introduced the repayable Pre-commercialization Assistance Program, sustainable development and youth initiatives.

CISTI: The 21st Century Library

NRC's Canada Institute for Scientific and Technical Information (CISTI) has become a modern, leading-edge library of the 21st century. Over the past five years, two NRC Information Centres were opened in London and Vancouver, bringing the total number to 10. Each centre offers scientific, technical and medical (STM) information relating to a specific sector or science relevant to its location (e.g. St John's: ocean and marine engineering), along with the complete range of CISTI services.

Every connected Canadian has access to CISTI services through the Internet. CISTI's latest innovation is the on-line search capability of NRC Research Press electronic journals. The size of its virtual library has increased from 400 journals in 1996–97 to 3000 journals in 1999–2000. Its collection of STM information remains one of the largest in the world, and it offers more and more possibilities through increasing numbers of partnerships with other large STM information libraries from around the globe.

Technology Transfer: Spin-offs, Licences and Patents

The Vision to 2001 took a more aggressive approach to entrepreneurship and technology transfer, and the results are in. Spin-offs are more and more common. Licencing revenues are growing steadily. The number of active patents and new patents has also gone up. NRC's intellectual property portfolio is a success story of its own. The number of licences has doubled; and the licencing revenue has increased exponentially.

From 1995 to 2000, 32 spin-off companies were launched in almost every area of NRC. In addition to high-tech areas such as photonics, biochips, medical imaging and computer modeling, NRC has also created successful spin-offs in hydraulic tooling and data mining. Several of NRC's spin-offs are

currently at the pre-IPO (initial public offering) stage, and one made its debut on the Toronto Stock Exchange in October 1999.

Contact Information
Policy, Planning and Assessment
National Research Council of Canada
Tel.: (613) 990-7381
Web site: **http://www.nrc.ca**

NATURAL RESOURCES CANADA

Over the past five years, Natural Resources Canada (NRCan) underwent a major downsizing and reorganization of its S&T programs. This included restructuring the former department of Energy, Mines and Resources and integrating the Canadian Forest Service (formerly Forestry Canada). The changes were guided by the goals of the federal S&T strategy and the new legislation creating NRCan, to stress the sustainable development of Canada's natural resources and to build on Canada's scientific and technological strengths in the natural resources sector.

NRCan now includes four science sectors — Earth Sciences, Energy, Minerals and Metals, and the Canadian Forest Service — as well as a Corporate Services Sector. The department supports a diverse mix of S&T programs from forest biodiversity research, risk assessment of geological hazards (landslides, floods) and mining regulatory reform, through to the development of advanced materials, community energy systems, geographic-information-systems infrastructure and value-added wood products. NRCan is both a major performer of S&T and a major sponsor of S&T within the natural resources sector.

In 1996, NRCan was the first department to develop an S&T management framework, setting out the main objectives and guiding principles for its S&T activities. The following year, NRCan produced the *Compendium of S&T Management Practices* to provide further guidance in implementing the framework. These principles and practices have evolved into more detailed frameworks at the sector level to guide S&T priority-setting, accountability and performance measurement. NRCan has also devoted substantial effort to measuring the impact and quality of its work by conducting impact studies, client satisfaction surveys and data quality audits.

Today, NRCan is a much smaller department with fewer S&T resources. The need to simplify its operations and increase the cost-effectiveness of its S&T programs has led to new approaches to S&T management and coordination. NRCan's response to the federal S&T strategy continues to gain momentum, as it continues to experiment with alternative S&T delivery models and research partnerships.

Increasing the Relevance of NRCan S&T

In response to the federal S&T strategy, new advisory bodies have been established to obtain advice on the appropriate focus of the department's S&T from a wider range of external stakeholders, as well as from provincial and territorial governments.

The Minister's Advisory Council on S&T (MACST) was created in 1998 to advise the minister on the strategic S&T needs of Canada's natural resources sector. Four parallel advisory boards have been established along sectoral lines: Earth Sciences, Energy S&T, Forest Research, and Minerals and Metals. Members of each of the sectoral advisory boards sit on the MACST to improve the integration of advice vertically in the department and horizontally across sectors.

Consultations with the provinces and territories remain a critical input to the department's S&T programs. In 1997, NRCan developed a comprehensive *Inventory of Mechanisms for Consultation and Collaboration with Provinces on S&T*, which revealed mechanisms at work at many levels of interaction. Follow-up efforts have focussed on filling gaps through new initiatives or agreements. Examples include:

- federal–provincial forest S&T advisory committees;
- letters of cooperation for bilateral partnerships in energy efficiency;
- the Federal–Provincial/Territorial Committee on Mineral Statistics;
- the Canadian Council on Geomatics; and
- the National Geological Surveys Committee, dedicated to cooperation in geological surveys through the Intergovernmental Geoscience Accord.

NRCan is equally committed to improving the science advice it provides to government and to Canadians. In 2000, NRCan carried out an in-depth analysis of its internal processes in relation to the federal Framework for S&T Advice and, in October 2001, NRCan hosted an Interdepartmental Workshop

to advance understanding and cooperation in implementing best practices in federal S&T advice.

Leveraging S&T Efforts and Resources

An increasing proportion of NRCan S&T is delivered through collaborative research agreements with universities, industry and other government partners. This remains a high priority for NRCan management to maximize both the use of scarce research dollars and the relevance and transfer of new knowledge and technologies.

The department's *Framework for Revenue Generation: External Funding and Collaborative Activities* sets out guidelines for cost-sharing, cost-recovery and collaboration with the private sector. NRCan contracts out S&T through different mechanisms. Examples include the Contracting-Out Bulletin, listing opportunities in geoscience and geomatics, and the Industrial Energy Research and Development Program, with a focus on small and medium-sized enterprises (SMEs). NRCan's ability to transfer its own knowledge and technologies has been enhanced through the creation of business development offices.

The department has increased its efforts to coordinate its S&T programs with other federal departments through mechanisms such as the 5NR MOU, the Northern S&T Strategy, the Program on Energy Research and Development, the National Biotechnology Strategy, Earth Observation for Sustainable Development of Forests and Federal Partnerships in Technology Transfer. The Metals in the Environment Research Network is a highly successful example of collaborative program delivery to develop a common information base for federal departments, industry and other governments, in formulating regulations and strategies for the sustainable use of metals.

Lastly, NRCan is developing closer ties with academic institutions. Over 200 NRCan scientists serve freely as adjunct professors in Canadian colleges and universities. Other measures that have been taken to share S&T resources include the training of graduate and post-graduate students in NRCan research establishments, new scholarship programs sponsored directly by NRCan or jointly with NSERC and SSHRC, and the sharing of specialized NRCan equipment and facilities with academic and other researchers.

Expanding the Boundaries of NRCan S&T Knowledge

To build on its basic strengths in the natural sciences and engineering, NRCan is drawing on wider sources of knowledge and information, including the humanities, public and community input, and international sources. For example, the Canadian Forest Service, in partnership with the Model Forests and the Network of Centres of Excellence in Sustainable Forest Management, is working on public participation models, local indicators of sustainable forest management and the use of traditional Aboriginal knowledge.

To improve its international intelligence gathering, NRCan is establishing bilateral agreements for the exchange and transfer of S&T knowledge, such as memoranda of understanding with Iran on geomatics and China on forest management. NRCan also benefits from membership in international S&T organizations such as the International Energy Agency, which allows the department access to restricted databases. Additionally, NRCan is forming the Global Mining Research Alliance with research organizations from leading mining nations (Australia, South Africa and the U.S.) to share knowledge and expertise, encourage innovation and promote sustainable development globally.

Reaching Out to Canadian Communities and Regions

NRCan management has identified NRCan's ability to respond to the needs of Canadian communities and regions as a priority requiring increased attention. NRCan S&T employees are now active in all 12 federal regional councils, including the two newly established councils in the territories. In Nunavut, NRCan's contribution to regional resource development is supported by the Canada-Nunavut Geoscience Office established in 1999, in collaboration with Indian and Northern Affairs Canada and Nunavut Sustainable Development, to increase geoscience activity and capacity building. Working with rural and urban communities across Canada, the Community Energy Systems Group is developing economical and energy efficient options for district heating and cooling systems through combined heat and power (cogeneration), waste heat recovery, thermal storage and the use of local sources of renewable energy.

NRCan's particular strengths in knowledge and communications infrastructure are being applied to improve access by individual Canadians and communities to information on the economic, environmental and social aspects of our natural

resources. A major departmental initiative, NRCan On Line, was started in 1997 to improve access to federal and external information sources, tools and applications. For example, under GeoConnections, a $60-million partnership created in 1999, the Sustainable Communities Initiative is helping Aboriginal, rural and northern communities to access and use geospatial information in their decision making.

Contact Information

S&T Secretariat
Natural Resources Canada
Tel.: (613) 947-9825
Web site: **http://www.nrcan.gc.ca**

NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA

Overview

The Natural Sciences and Engineering Research Council of Canada (NSERC) is Canada's national instrument for making strategic investments in training and research in the natural sciences and engineering (NSE). Annually, NSERC invests over $600 million in people, discovery and innovation at Canadian universities and colleges. Through its investments, NSERC builds Canada's capabilities in S&T and supports innovation that drives the economy and improves the quality of life of all Canadians.

The government has set a new goal for Canada: moving to fifth place in R&D investment per capita among OECD (Organisation for Economic Co-operation and Development) countries by 2010. NSERC investments in the training of highly qualified people are key to meeting this challenge and unlocking Canada's R&D potential. NSERC is an integral component of the federal government's Innovation Agenda. In the review that follows, some NSERC initiatives are related to the 1996 federal S&T strategy and the Industry Portfolio's Action Plan, *Science and Technology for the New Century*.

Implementing the Federal S&T Strategy: Securing Highly Qualified People for Today and Tomorrow

Through its promotion of scientific research, NSERC helps improve Canada's technological competitiveness and long-term productivity. Canada's future capabilities in S&T depend on today's graduate students, postdoctoral fellows and junior faculty.

Over NSERC's 21-year history, more than 55 000 master's and doctoral students and young research professionals have benefited from NSERC support. Making Canada fifth among nations in R&D investment will require many more highly qualified people trained at Canadian universities and colleges.

NSERC invests in the advanced training of young people in two ways. Through national competitions, it provides scholarships and fellowships to selected individuals. It also provides indirect support (e.g. a researcher may hire a student or postdoctoral fellow using an NSERC grant). On average, half of the grant money awarded to researchers is spent on the training of future researchers.

Through its university-industry partnership programs, NSERC exposes students to the opportunities available in Canadian industry and acquaints Canadian industry with the talent coming out of Canada's universities. These programs help retain talented youth in S&T fields and in Canada, beyond their graduation.

NSERC's investments help satisfy Canada's demand for highly skilled people who will be able to pursue various knowledge-intensive careers within any sector of the economy. Over the last decade, graduates in the natural sciences and engineering have experienced far less unemployment (1.7 percent) than the norm (8 percent for Canada). The vast majority of former NSERC postdoctoral fellows (88 percent) are still engaged in research as university professors, research scientists or engineers.

About 25 percent of Canadian university R&D funding in NSE can be attributed directly to NSERC. Every year, NSERC supports approximately 16 000 students, postdoctoral fellows, technicians and research associates, supervised by about 9000 professors who are principal investigators.

NSERC is seeing many bright young new applicants who are launching their research careers. These new professors are critical to Canada's future capabilities in S&T; they generate new knowledge and innovations, and also train highly skilled people. Supporting them is NSERC's first priority.

To help recruit the next generation of scientists and engineers, NSERC also acts as a science promoter. The council actively supports the popularization of new knowledge in the NSE and promotes these disciplines as career choices. A broad-based interest in science is essential for a society to succeed in the

knowledge-based economy. For this reason, we must attract our youth to learning opportunities and make sure they get the tools they will need to succeed.

NSERC's science promotion initiative has four components. The most important is an active media relations program that has resulted in thousands of science stories appearing in Canadian newspapers and on radio and TV. In an average month, NSERC-related newspaper articles reach almost four million readers. Another component is the Michael Smith Awards for Science Promotion, which recognizes individuals and groups for their outstanding contributions to the promotion of science. Through the NSERC SPARK Program, youth are involved first-hand in *Students Promoting Awareness of Research Knowledge*, by writing stories that promote research news to the public. Launched as a pilot project in 1999, SPARK now involves students from 17 universities. PromoScience, a program of grants to not-for-profit organizations, helps Canadian youth learn about opportunities in science and engineering. Motivate Canada, one of over 60 organizations awarded funding through PromoScience, develops innovative didactic products such as an electromechanical robot that teaches young people the practical side of mathematics, engineering and physics.

Ensuring that "Invented in Canada" Translates into "Made in Canada"

To maximize the benefit from taxpayers' investments in both basic and project research, NSERC added a condition on all grants to ensure that any resulting potential intellectual property is disclosed to the grantee's university and that an effort is made to obtain the greatest possible economic benefit to Canada from commercial activity.

In 2001, NSERC expanded its five-year old Intellectual Property Management Program through a partnership with the Canadian Institutes of Health Research and the Social Sciences and Humanities Research Council of Canada. The program will help Canadian universities and hospitals learn how to protect and market their intellectual property, to transfer their knowledge and technology to potential users, and to promote the professional development of intellectual property specialists.

Companies of all sizes in all sectors participate in NSERC partnership research programs. For every dollar NSERC invests in its university-industry programs, another $1.70 is levered from industry in support of university-based project research. Such NSERC-funded research has led directly or indirectly to the creation of new value-added industries, products and processes in Canada.

NSERC-funded research also led to the creation of 111 spin-off companies, which employed over 7500 Canadians and generated over $1.3 billion in annual sales.

Innovating Through Powerful Partnerships

Through cost-sharing in Research Partnership Agreements with federal government departments and agencies, NSERC builds strong linkages between the private sector and researchers in universities and federal laboratories. For example, the NSERC/National Research Council of Canada funding for fuel cell research supports R&D needed to reduce the cost of this clean and efficient energy technology, an area in which Canada is a world leader.

NSERC's Innovation Platforms are designed to accelerate and intensify Canadian research in areas that present a high potential for Canada to become a leader in S&T. Innovation Platforms are new, flexible mechanisms that will provide leadership, planning and focus for such research. The first Innovation Platform is the NSERC Nanoscience and Nanotechnology Innovation Platform, launched in November 2001.

In partnership with Dalhousie University's computer science faculty, NSERC is supporting a Student Entrepreneurship Program. The program fosters the creativity and innovative spirit of students through projects that culminate in a product prototype and a start-up company.

The Networks of Centres of Excellence are innovative research partnerships of universities, the private sector and governments that address large problems of critical importance to Canadians. In an average year, the existing 22 networks will involve approximately 5000 participants (including over 3600 research associates and students), create over 17 spin-off companies and assist almost 1500 university graduates to obtain employment in industry.

Science for Sustainable Development

NSERC supports research that is advancing sustainable development studies and developing tools for environmental assessment. For example, NSERC-funded research networks

build the critical mass and interdisciplinary teams necessary to address complex issues in environmental sciences, such as:

- metals in the environment
- coasts under stress
- climate variability
- biocontrol.

The Biocontrol Network contributes to the sustainability of industries. It assists greenhouse and nursery plant industries by developing environmentally friendly strategies for pest and disease control.

Turning inventions into products that are safe, economical and environmentally friendly is the job of design engineers. The council identified the need to improve the level and quality of design engineering activity in our universities. NSERC is establishing 16 Industrial Chairs in Design Engineering, five of which will focus specifically on climate friendly production-and-process technologies to help industry reduce greenhouse gas emissions and other impacts on the environment, while enhancing competitiveness.

Three NSERC programs are targeted to support research in the Canadian North: the Northern Research Chairs Program, the Northern Research Postgraduate Scholarship Supplements, and the Northern Research Postdoctoral Fellowship Supplements. These programs, in part, respond to the recommendations of the NSERC and SSHRC Task Force on Northern Research.

International Research Collaboration Extends Canada's Reach

NSERC created three mechanisms to extend Canada's S&T linkages internationally. One of these, offered in partnership with the National Research Council of Canada's Industrial Research Assistance Program, supports the joint participation of university researchers and Canadian small and medium-sized enterprises (SMEs) in international projects. The other two are a small program — the International Opportunity Fund — to help Canadian researchers establish international collaborations, and a large one — the Collaborative Research Opportunities Grants — to support collaborative research.

Canada is an active member of the global research community; about 35 percent of Canadian scientific papers are co-authored with international partners.

Contact Information

Natural Sciences and Engineering Research Council of Canada
Tel.: (613) 995-6295
Web site: **http://www.nserc.ca**

PARKS CANADA

Trends and Highlights

Since the 1960s, Parks Canada has used applied sciences and related scientific activities to understand national parks and historic sites; to help protect their cultural and natural values; and to provide information for interpretation and outreach, environmental impact assessments, ecosystem restoration, visitor activities and, indeed, all aspects of park management. In 1988, a *National Parks Act* amendment required that the protection of ecological integrity (EI) be the prime consideration in all aspects of park development. Parks Canada defines EI as "a condition that is determined to be characteristic of its [a park's] natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes." It has also instituted an EI monitoring framework for reporting to Parliament on the state of the parks. Two such reports have been published since 1996. Both addressed the health of park ecosystems and the stresses acting upon them, such as regional habitat loss and acid rain. EI is now at the forefront of Parks Canada policy, along with the need for a stronger science culture to understand and measure it, and to integrate it with day-to-day and long-range park management.

A turning point came in October 1996 with the release of the Banff-Bow Valley Enquiry report, an examination of the impact of park development on the ecosystems of the most visited and best-known part of natural Canada. With strong ministerial endorsement, Parks Canada has since enhanced its conservation science and practices, capped urban development to protect wildlife corridors, restored ecosystems through active fire management, removed infrastructures and facilities, and built highway overpasses for wildlife. The benefits are already evident. Wolves once again move through the valley, restoring the natural balance between elk and aspen forests. A rigorous science program, conducted by staff and government and university scientists, was critical to the success of the Bow Valley ecological restoration efforts.

The lessons of the Banff-Bow Valley study have been applied to all parks. Each must now prepare an EI statement to define

ecosystem management goals as the centrepiece of management plans. In October 1998, the Minister of Canadian Heritage appointed an expert panel to examine the ecological integrity of Canadian national parks. In March 2000, the panel presented 127 recommendations on the importance of a management culture founded upon science, the integration of western and traditional knowledge systems, an enhanced science capacity, and the benefits of partnerships in both ecosystem stewardship and science. The minister endorsed its recommendations. In Red Book III, the government indicated that it would provide resources, *inter alia*, for research and actions on EI. As well, the *National Parks Act* of 2000 enshrined EI as the first priority in all aspects of park planning and management. The January 2001 Speech from the Throne highlighted the government's resolve to implement a plan to restore existing parks to ecological health.

The adoption of the federal S&T strategy, the reports of the Council of Science and Technology Advisors, and the Cabinet endorsement of the science advice framework helped to prepare the way for these and other park science developments. The pre-eminence of EI in national park management has been mirrored in the concept of commemorative integrity (CI) for national historic sites. Parks Canada defines CI as a measure of the health and wholeness of a national historic site. For a site to have CI, its cultural resources of national significance must not be under threat, its messages of national significance must be communicated to the public, and its historic values must be respected. CI statements will now be at the heart of all national historic site management plans. Both CI and EI statements require a thorough understanding of the heritage values of a place, their origins, and their linkages to other heritage values and to the surrounding region and its stakeholders.

Parks Canada's march to become a science-based agency reflects three of the seven principles of the 1996 federal S&T strategy, namely the benefits of partnerships, preventive approaches and sustainable development, and a strong science culture. Here are some highlights:

- Partnership established with the Bedford Institute of Oceanography and the Canadian Museum of Civilization, to understand submerged ancient landscapes off the coasts of Prince Edward Island, the Queen Charlotte Islands and the B.C. mainland.
- Active membership on research teams in five Model Forests, a program coordinated by Natural Resources Canada.
- Memorandum of Agreement signed with the Canadian Forestry Service to ensure scientific and technical cooperation in ecosystem management.
- Technologies introduced such as geographic information systems, global positioning systems and ground penetrating radar for locating, mapping, analysing and modelling buried and surface features, as well as human occupation at national historic sites.
- Leading the East and West Slopes Grizzly Bear Research projects in the southern Rocky Mountains.
- Contaminated sites, largely resulting from fuel spills, landfill seepage or heavy metals, cleaned up on former industrial sites. Assessment techniques include electromagnetic surveys, monitoring wells and soil analyses. The agency has remediated 37 sites, mostly in the past five years.
- Partnerships established with Public Works and Government Services Canada to research ways to extend the life of historic building materials, ranging from Haida mortuary poles to mortar to historic timber structures and frames.
- Science advisory boards and/or coordinating committees established for most national parks.
- Aboriginal affairs secretariat established, in part to engender the use of traditional knowledge in park management; and an approach developed to incorporate Aboriginal cultural landscapes in park and site management and interpretation.
- Partnership established with the Sahtu Secretariat and the Prince of Wales Northern Heritage Centre to identify heritage places and sites, and associated oral histories of the Sahtu region.
- Guidelines adopted for the development of CI statements for all national historic sites and EI statements for all national parks; Park Management Planning Guide revised to reinforce the primacy of EI.
- Historical and archeological research and analysis conducted to update the National Historic Sites of Canada System Plan based on a comprehensive thematic assessment of Canadian history.

- Working groups established to develop science policies and strategies for natural and cultural resource management.
- Human-use management guidelines adopted based on social science research into human uses of parks and sites and appropriate visitor activities.
- Workshops conducted to train managers in cultural resource management and ecosystem management.
- EI orientation course developed for all employees.
- Executive Director of EI position established as the agency's science-advice champion, with a seat on the Parks Canada executive board.
- Ecosystem Science Division established at the national office to coordinate park research and monitoring programs, provide expert advice and policy direction in relevant scientific disciplines, manage the agency's species-at-risk program, develop S&T partnerships, and represent the agency on interdepartmental and intergovernmental science bodies.
- Policy adopted to protect park and site ecosystems by using an active adaptive environmental management approach.
- Increased presence of science-based information on Parks Canada's Web site, and greatly increased scientific publication in its research, review and report series.

Contact Information

Ecological Integrity Branch
Parks Canada
Tel.: (819) 994-3244
Web site: **http://www.parkscanada.gc.ca**

SOCIAL SCIENCES AND HUMANITIES RESEARCH COUNCIL OF CANADA

The Social Sciences and Humanities Research Council of Canada (SSHRC) is the federal agency responsible for supporting university-based research and training in the social sciences, humanities, education and management, and for charting directions for the Canadian research effort in these fields. SSHRC-supported research covers a breadth of disciplines ranging from economics, business studies, ethics, education, law, history and literature to philosophy, psychology, sociology, environmental studies and religious studies, among others. SSHRC supports basic research, targeted research on issues of national importance, the training of highly qualified personnel, and the broad dissemination of knowledge for the benefit of Canadian society.

Following the 1996 federal S&T strategy, SSHRC developed several programs and initiatives to enhance research and promote innovation and partnerships with users of research. Over the past five years, SSHRC has invested over $190 million in its research grants programs and has supported more than 3000 new projects. It has also invested over $146 million in its fellowships programs and helped train more than 3500 graduate students in the social sciences and humanities. It has developed over 20 new joint initiatives with public and private sectors, and three major special programs.

The following examples illustrate some of SSHRC's major achievements and contributions in meeting the commitments of the federal S&T strategy.

Major Achievements: Addressing Knowledge Gaps and Building Partnerships

New Economy, New Ideas, New Choices: Initiative on the New Economy

With a special allocation from the federal government, in spring 2001, SSHRC launched the Initiative on the New Economy (INE), a major initiative to support research that will help keep Canada at the forefront of the knowledge economy. The INE will explore the challenges and opportunities of the new economy in four major areas of research: the nature of the new economy, management and entrepreneurship, education and lifelong learning. Expected results include:

- a better understanding of the economic, social and cultural interaction associated with rapid technological change and the growth of new knowledge;
- the major factors that influence productivity, growth and innovation in Canadian firms and other organizations;
- how emerging technologies, new knowledge and the accompanying economic, social and cultural changes are transforming learning and education; and
- how learning and education can respond effectively and creatively to these changes.

Finally, the INE will examine the concepts, policies and practices that best support lifelong learning in Canada. The new knowledge will greatly strengthen the ability of decision makers in the public, private and not-for-profit sectors to devise

new policies and practices that will enhance Canadians' success in the new economy. The INE is a special investment of $100 million over five years.

An Innovative Model: Community University Research Alliances

In 1999–2000, SSHRC launched the Community University Research Alliances (CURA) program, an innovative model to develop knowledge and expertise geared to community development through broad-based research alliances between universities and local and regional action groups. Thus far, 37 CURAs have been established, representing an investment of over $22 million. CURAs focus on issues such as evaluating social strategic planning in Newfoundland, sustaining rural communities in Nova Scotia, developing a recreation and tourism industry in mid-northern Quebec, countering the effects of climate change on water resources in Ontario, rehabilitating the inner-city core in Winnipeg, and the effectiveness of law enforcement and justice related to partner violence in the Prairie provinces.

Interdepartmental Collaboration: NSERC/SSHRC Task Force on Northern Research

As part of its strategy to address knowledge gaps in key areas, SSHRC partnered with Natural Sciences and Engineering Research Council of Canada in launching a task force to assess the state of research on the North. The task force report, *From Crisis to Opportunity: Rebuilding Canada's Role in Northern Research* (2000), identified the key areas in which Canada urgently needs to rebuild its university-based northern research capacity to address unprecedented social, physical and environmental challenges currently facing the region. The task force report and recommendations are now a core part of the federal government interdepartmental strategy to inform policy and program development in northern S&T.

Targeting Research for Socio-Economic Development

SSHRC pursues its strategy to link research with key socio-economic and cultural policy areas through multidisciplinary collaboration and partnerships between researchers and public and private sector organizations. Over the last five years, SSHRC has launched 20 targeted research programs to generate policy-relevant knowledge and to build capacity on key issues for Canadian society. Sixteen of these initiatives have been launched in partnership with government departments, non-government organizations and community groups, including the following:

- Immigration and the Metropolis (with Citizenship and Immigration Canada and seven federal partners) — a cooperative international project to provide multidisciplinary, comparative, policy-relevant knowledge on the effects of international migration on urban centres.
- Research and Training Incentives — to supply the knowledge and highly qualified personnel needed in forest management (with the Canadian Forest Service) and on emerging issues relating to Canada's relationship with Asia and with Latin America (with the International Development Research Centre).
- The Non-Profit Sector in Canada (with the Kahanoff Foundation) — to increase our understanding of the role non-profit organizations play in society, in contributing to the development of effective public policy in this area and in informing public policy.
- Valuing Literacy (with Human Resources Development Canada) — to stimulate research and develop capacity on adult literacy and guide policy decisions in this area.
- Ocean Management National Research Network Initiative (with Fisheries and Oceans Canada) — to conduct new research, create knowledge and accelerate the application of critical thinking and best practices to develop sustainability within oceans management.
- Canadian Tobacco Research Initiative (with the National Cancer Institute of Canada, the Canadian Cancer Society, Health Canada, the Heart and Stroke Foundation of Canada, the Ontario Tobacco Research Unit and the Ontario Ministry of Health) — to stimulate a sustained and coordinated tobacco-control research agenda that has a direct impact on tobacco-control programs and policies across Canada.

SSHRC's Joint Initiatives strategy has generated almost $22 million in additional funding since 1996, for social sciences and humanities research.

With its own financial resources, SSHRC has also launched four new thematic programs to sustain policy-relevant research on productivity; social cohesion; the challenges and opportunities of a knowledge-based economy; and on society, culture and the health of Canadians.

SSHRC also established a series of programs to help integrate the social dimension of health and build social sciences and humanities expertise to contribute to the newly created Canadian Institutes of Health Research.

Moving Forward

SSHRC will continue to build knowledge and skills, and help sustain innovation, competitiveness and quality of life through its granting programs and activities. It will continue to develop new initiatives, to enhance strategic training opportunities for youth, to promote research on key areas that respond to emerging socio-economic issues, and to reinforce the research and training base. It will continue to expand its partnerships with the private, public and not-for profit sectors and to enhance its knowledge brokering capability to make the results of SSHRC-funded research widely available.

Contact Information

Social Sciences and Humanities Research Council of Canada
Tel.: (613) 992-3146
Web site: **http://www.sshrc.ca**

STATISTICS CANADA

Statistics Canada is Canada's central statistical agency with a mandate to collect, compile, analyse and publish statistical information on the economic, social and general conditions of the country and its citizens.

The agency plays a central role in informing public policy discussion. Domestic issues such as those covered by the media very often rely on information produced by Statistics Canada. The Speech from the Throne identified ten priorities:

- creating opportunity
- innovation
- skills and learning
- connecting Canadians
- trade and investment
- children and families
- good health and quality care
- a clean environment
- strong and safe communities
- a vibrant Canadian culture.

Every one of these priorities requires statistical analysis and research. The agency's data help quantify the issues, and its objective analyses make a significant contribution to the identification of potential options or solutions.

Maintaining the relevance of the Statistics Canada program by meeting these information needs will always be a primary goal. To accomplish this, Statistics Canada relies on two pivotal instruments. These are the advice and guidance it receives from external consultative bodies, and the agency's rigorous planning and performance monitoring system and processes.

Science Advice

External consultative bodies include the following:

- the National Statistics Council;
- 14 professional and scientific advisory committees (including the Advisory Committee on S&T Statistics);
- bilateral relationships with key federal departments; and
- the Federal–Provincial Consultative Council on Statistical Policy.

Active partnerships are maintained by Statistics Canada with the provinces and territories. Of particular interest are special initiatives in the areas of health, education and justice.

- Health — Statistics Canada priorities are developed with the assistance of the Board of Directors of the Canadian Institute for Health Information. The board comprises senior provincial and private sector representatives and the Chief Statistician.
- Education — The Canadian Education Statistics Council is a joint creation of Statistics Canada and the Council of Ministers of Education. The council, comprising the Chief Statistician and provincial/territorial deputy ministers of education, advises the Chief Statistician on the Education Statistics Program at Statistics Canada.
- Justice — The Justice Information Council comprises federal and provincial deputy ministers responsible for justice policies and programs, and the Chief Statistician. The council provides advice to the Chief Statistician on the Justice Statistics Program at the Canadian Centre for Justice Statistics, within Statistics Canada.

Planning and Performance Monitoring

The performance of a national statistical agency is essentially a multidimensional concept in which different audiences are interested in different dimensions of its performance. Statistics

Canada recognizes that there exists an ethical responsibility to report on dimensions of performance that are not visible from outside the agency. It is also of the view that there are four primary dimensions of performance that are paramount to a national statistical agency and each can be linked to a particular stakeholder group that has an interest in its performance. These groups are:

- Users of the information products who have an interest in the quality of those products, where "quality" is broadly defined as fitness for use.[3]
- Funders of the activities, the taxpayers of Canada and those in government charged with managing public funds, who have an interest in financial performance, including efficiency, good management and proper use of taxpayers' money.
- Respondents to the surveys and their representatives, who have an interest in the response burden imposed on them, in how the agency interacts with them, and in the care with which the agency protects the information they have confided in it.
- The employees on whom the agency depends and the agencies charged with human resource management standards in government, who have an interest in performance in human resources management.

Each of these stakeholder groups is addressed in regular reports to Statistics Canada's internal management committees. However, it is not possible to produce direct quantitative results or output measures for all aspects of performance.

In terms of information quality, Statistics Canada has chosen a broad concept based on fitness for use. There are six aspects: relevance, accuracy, timeliness, accessibility, interpretability and coherence. Some of these can be quantified; some are best described qualitatively, while others can be assessed only in terms of the processes followed by the agency.

S&T Achievements

Information System for Science and Technology Project

As well as being the largest social science department or agency in the federal government, Statistics Canada maintains a growing program of S&T statistics as part of the Information System for Science and Technology Project. Under the project, surveys are conducted on R&D activities, invention, innovation, technology diffusion and related human resource development, measures and analyses of linkages among actors in the S&T system, and analyses of outcomes.

The program is progressing towards the analysis of the impact of S&T activity, and it is guided in this by *Science and Technology Activities and Impacts: A Framework for a Statistical Information System, 1998*.[4] The plan takes the program from its developmental stage, funded by Industry Canada from 1996 to 1999, to a new level as an integral part of the work of the agency. Funding for this strategic development for 1999 to 2003 is part of a $20-million-a-year package, coordinated by the federal Policy Research Committee, to reduce gaps in the statistical system.

The survey of Federal Science Expenditures and Personnel provides information on the industrial sector, geographic region, and socio-economic objective of federal science expenditures and personnel. A longer-term objective of this and the rest of the S&T statistics program is to demonstrate the outcomes of government S&T spending. Recent releases highlight the nature of innovative manufacturing firms, the characteristics of biotechnology firms, and trends in Internet sales and Internet shopping. Selected research is summarized in the *Innovation Analysis Bulletin*, available free of charge on Statistics Canada's Web site, as are related working-paper series and questionnaires.

Statistical Research Data Centres

Statistics Canada, in collaboration with the Social Sciences and Humanities Research Council of Canada, launched an initiative that will help strengthen the country's social research capacity, support policy relevant research, and provide insights on issues important to the Canadian public. This ongoing initiative involves creating nine research data centres that were opened at universities across the country in 2001. Six of the centres will receive funding from the Canada Foundation for Innovation.

3. To ensure "fitness for use," Statistics Canada developed the Quality Assurance Framework in 1998–99. This is the central framework through which the agency ensures information quality by conducting an assessment of progress and performance on the basis of six aspects: relevance, accuracy, timeliness, accessibility, interpretability and coherence. The Auditor General's Report in April 1999 contained a chapter on "Managing the Quality of Statistics." The Auditor General's review was based on the Quality Assurance Framework and, in conclusion, noted Statistics Canada's commitment to producing high-quality statistics and improving quality on a continuing basis.

4. Cat. No. 88-522-XPB.

Researchers will conduct work under the terms of the *Statistics Act*, as would any other Statistics Canada employee. This means that the centres are protected by a secure access system; that computers containing data will not be linked to external networks; that researchers must swear a legally binding oath to keep all identifiable information confidential; and that the results of their research will be published by Statistics Canada.

The first Research Data Centre opened in December 2000 at McMaster University in Hamilton, Ontario. The eight remaining centres opened in 2001 and are hosted by the Université de Montréal, Dalhousie University, and the universities of Toronto, Waterloo, Calgary, Alberta, New Brunswick (Fredericton), and British Columbia.

Environmental Indicators

A system of environmental and resource accounts was added to the current System of National Accounts to permit the analysis of the impact of the economy on the environment and vice versa. Indicators include the evolution of Canada's natural wealth, the extent of the nation's natural resource base and the degree to which this base is exploited, the use of resources, the generation of greenhouse gas emissions per unit of household purchases, and environmental protection expenditures by businesses and governments.

Contact Information

Science, Innovation and Electronic Information Division
Statistics Canada
Tel.: (613) 951-2199
Web site: **http://www.statcan.ca**

TRANSPORT CANADA

Transport Canada (TC) has been delivering on its commitment to innovative transportation scientific research and technological development by supporting the guiding principles of the Government of Canada's S&T strategy and through the achievement of the department's strategic objectives of security, safety, accessibility, energy efficiency and environmental sustainability. TC's S&T priorities are to acquire new scientific knowledge and develop innovative technological solutions for the best transportation for Canada and Canadians.

In 1996, stemming from a major restructuring of Transport Canada, a new framework was developed to govern the process of selecting, funding and implementing technology R&D projects. This new framework included the establishment of a Research and Development Management Board (RDMB), which determines departmental S&T priorities and allocates central resources to these priorities. In addition, in support of the decision-making functions of the RDMB, a Technical Advisory Committee was established giving specialist and technical advice.

Highlights of Research Achievements

Security

Recent terrorism events have increased the requirement for R&D for new sophisticated security systems — a top priority for TC. Long-term cooperative research efforts with U.S. security authorities have succeeded in developing advanced technologies to provide reliable and effective Explosion Detection Systems.

Air Safety

The Joint Winter Runway Friction Measuring Program is an international research initiative managed by TC. To date, the research program has collected the results of over 300 valid test runs with aircraft and 15 000 with ground vehicles. The data are being used to develop an international runway friction index that will assist pilots and airports in determining safe landing distances in winter conditions.

A significant result of long-term TC research on locator beacons is the recent approval of an Emergency Locator Transmitter integrated with Global Positioning System information that provides distress-alert and location information to search-and-rescue authorities anywhere in the world.

TC has received a recognition award from the European Organization for Civil Aviation Equipment for its research work on the development and deployment of minimum performance specifications for ground ice-detection systems. Undetected frozen contamination may pose a serious hazard to aircraft at takeoff, and ground ice-detection systems provide ground and flight crews with accurate information on the condition of aircraft surfaces just prior to takeoff.

TC and the U.S. Federal Aviation Administration are considering recommendations for the most effective locations for flight data recorders. The recommendations, based on TC research, call for the use of combined flight data recorders and cockpit voice recorders, both in the cockpit and in the rear of an aircraft, to avoid loss of data and to facilitate accident investigations.

Marine Safety

An ice navigation simulator developed by TC is now ready for operational use. The PC-based, low-cost simulator uses virtual reality, interactive techniques, and multimedia hardware and software to facilitate training and to reduce the requirements for on-board experience.

Road Safety

A feasibility study of the System for Technological Applications in Road Safety (STARS) developed by Quebec's automobile insurance board, was completed in collaboration with the Alberta and Manitoba governments. A computer- and communications-based traffic safety system, STARS facilitates the work of police officers by automating data entry, data retrieval, and the issue of citations and reports. It can also provide access to provincial and national police information services, resulting in an elevated level of security.

Intelligent Transportation Systems

In continuing research work designed to streamline the multimodal operations at the Port of Montréal, researchers have completed a design for an extranet system, facilitating effective and efficient communication among all those involved in the port's activities: shipping lines, terminal operators, freight forwarders, trucking and rail companies, and government authorities.

In 2000, TC contributed to the establishment of an Intelligent Transportation System (ITS) Centre at the University of Toronto. This contribution was instrumental in leveraging the participation of 16 public and private sector funding partners, who have contributed over $3 million towards the establishment of the ITS R&D test-bed and training facilities.

Human Factors Research

TC has been conducting studies and has participated in cooperative research on operator fatigue with national, provincial and U.S. authorities, as well as industry and research organizations. The work covers commercial vehicle drivers, marine and airline pilots, air traffic controllers and ships' crews. The research has led to many improvements in fatigue management. This year, TC published a compendium of best practices for fatigue countermeasures in transport operations. The compendium contains key facts, implementation strategies, and results related to the most effective use of various countermeasures in all transportation modes. For further information on research outcomes refer to **http://www.tc.gc.ca/tdc/index.htm**

Sustainable Development

TC is committed to making sustainable development a fundamental principle of policy development, transportation safety regulation and program delivery, and to ensuring that all of its operations are conducted in an environmentally responsible manner. For further information refer to **http://www.tc.gc.ca/programs/environment/menu.htm**

Sustainable Development Strategy

The core of Transport Canada's sustainable development strategy lies in the challenges and commitments for action by the department. TC has identified seven strategic challenges for sustainable transportation in Canada, and 29 specific commitments for action by the department to address priority areas. Each commitment is accompanied by concrete deliverables and performance measures to mark progress.

Moving On Sustainable Transportation

Transport Canada has established a Moving On Sustainable Transportation (MOST) program to support projects that produce the kinds of education, awareness and analytical tools we need if we are to make sustainable transportation a reality. MOST is providing funding to help support projects that:

- provide Canadians with practical information and tools to better understand sustainable transportation issues;
- encourage the creation of innovative ways to promote sustainable transportation; and
- achieve quantifiable environmental and sustainable development benefits.

An example of one successful project is the Black Creek Regional Transportation Management Association Project. Congestion and poor air quality affect productivity, business activity, investment decisions and quality of life. The implementation of transportation-demand-management measures in north Toronto will encourage residents and employees in this area to use alternative modes of transportation, thus creating a more efficient transportation system.

Climate Change

Transport Canada's component of the Government of Canada's Action Plan 2000 on Climate Change is substantial. It responds to the fact that, while fuel efficiency is improving, it is not keeping pace with annual increases in the use of

transportation. The five new transportation research programs in the plan are:

- Urban Transportation
- Freight Transportation
- Vehicle Efficiency
- Future Fuels (ethanol)
- Fuel Cell Vehicles.

The programs take a balanced approach towards vehicle and fuel technology, behaviour change and infrastructure.

Urban Transportation Showcase Program

The Urban Transportation Showcase program is a five-year program created to demonstrate, evaluate and promote effective strategies to reduce greenhouse gas (GHG) emissions from urban transportation. TC is working in partnership with provinces and municipalities to establish a number of transportation "showcases" in selected cities, to demonstrate and evaluate a range of urban transportation strategies within a broad planning framework. The impacts of these strategies on other urban challenges such as smog reduction, congestion and infrastructure costs are also being evaluated. This new information will lay a foundation for the adoption of effective, integrated GHG emission-reduction strategies in urban centres across Canada by 2010.

Freight Efficiency and Technology Initiative

The Freight Efficiency and Technology Initiative is one of five transportation measures under the Government of Canada Action Plan 2000 on Climate Change. The five-year initiative is designed to reduce the growth of GHG emissions from freight transportation. Transport Canada is leading the $14-million initiative with the cooperation of Natural Resources Canada.

A New Direction for Transport Canada in Transportation S&T

In April 2001, the Minister of Transport directed that the department undertake a Transportation Blueprint. The purpose of the initiative is to develop a strategic plan for the Government of Canada that will address transportation challenges in the next 10 years and beyond. By building capacity for innovation and S&T, we will potentially set ourselves apart from global competition and create the best in transportation safety and security. A major component of this new strategic plan is to prepare Canada's transportation system to optimize transformative technological opportunities in the 21st century, where TC will adopt a coordinated and strategic approach to broaden and strengthen its support in R&D activities and knowledge flows. We are challenged to develop a strong range of new partnership arrangements with the private sector, provinces and academia.

In addition, the Transportation Blueprint will respond in a strategic manner to the recommendations of the 2001 *Canada Transportation Act Review* report. From an S&T perspective, the review, *inter alia*, calls for the following:

- build on efforts to invest in new and incremental transportation research networks;
- establish transportation research chairs;
- increase Web publications;
- allocate a specified portion of Transport Canada's annual budget to research; and
- develop professional and technical skills in the field of transportation.

These initiatives are key to data-driven decision making and to optimizing the opportunities for Canada's transportation system in the 21st century.

Contact Information

Research & Development
Transport Canada
Tel.: (613) 991-6027
Web site: **http://www.tc.gc.ca**

WESTERN ECONOMIC DIVERSIFICATION

Western Economic Diversification (WD) has placed a high priority on innovation since its inception in 1987. Following the 1996 federal S&T strategy, WD has developed several specialized programs and tools to support and enhance the western Canadian innovation system, including Western Economic Partnership Agreements, loan funds in partnership with commercial lending institutions, the First Jobs in Science and Technology program, and the Canada Foundation for Innovation Support Program. In the fiscal year ending March 2001, WD commitments to innovation represented 44 percent of total grants and contributions.

WD's current priorities build on the activities put forth in the 1996 Industry Portfolio S&T Action Plan. The review below highlights WD's work with partners to address gaps in the western Canadian innovation system and efforts to strengthen it.

Improving Knowledge Infrastructure and Capacity

WD has taken a multi-faceted approach to improving knowledge infrastructure and capacity by working with partners such as provincial governments, other federal departments, industry associations and universities. Investments in cluster-planning studies, key knowledge infrastructure and in facilitating access to federal S&T infrastructure programs have been made.

WD is supporting planning efforts in urban centres throughout the West, including Edmonton, Calgary, Regina and Winnipeg, to undertake cluster strategies. The strategies build on the 1996 report *Building Bridges: Cluster Based Economic Development for Western Canada*. WD is a partner in the development of the Greater Edmonton Competitiveness Strategy. The diagnostic stage identified eight economic clusters that would form the basis of future economic development and growth for the greater Edmonton region. Advanced manufacturing, biomedicine/biotechnology, information/media services, and transportation and logistics are included in the key clusters focussing on innovation. Teams are currently developing specific strategies and opportunities within each cluster. Several smaller western communities plan to undertake similar planning studies.

Knowledge infrastructure provides the foundation for clusters. WD has made strategic investments in key technology infrastructure, leading to new cluster development in the West. Examples include investments in life sciences (proteomics, filmless radiology intranet), information technology (new media, geomatics, telehealth), climate change technologies (greenhouse gas sequestration and waste management co-composting), platform technologies such as fuel cells and synchrotron technologies, and convergence technologies such as bio-informatics.

WD, the National Research Council of Canada and the Province of British Columbia joined to establish Fuel Cells Canada (FCC). FCC will collaborate with government, the private sector and educational institutions to encourage a cluster of manufacturers and service suppliers for existing and new fuel cell systems developers. FCC identifies and coordinates demonstration projects and fosters the development of fuel cell industry clusters in B.C. It also plays an awareness role and demonstrates to the public the benefits of fuel cell technology. The fuel cell industry builds on British Columbians' desire to protect the environment, coupled with the need to enhance economic opportunity. It is estimated that by 2020 the potential market demand for fuel cells will be $145 billion worldwide and that it will create 15 000 jobs per billion dollars in demand for fuel cells.

To increase western participation in federal programs that support infrastructure, WD's Canada Foundation for Innovation Support Program (CFI-SP) assists western institutions in making applications to the foundation. WD's support of $593 000 has directly contributed $32 million in CFI awards to western universities and institutions. In addition, a CFI-SP project resulted in a national award of $20 million, which has been made to national libraries.

The Canadian Light Source (CLS), with a capital investment of $173.5 million, is Canada's largest R&D facility. Located on the campus of the University of Saskatchewan in Saskatoon, the CLS will be Canada's sole source of synchrotron light, a high-intensity source of infrared, ultraviolet and x-ray radiation that is an advanced materials research tool. The CLS will serve industrial and academic users throughout Canada and will focus on research investigation in the following four key areas:

- biotechnology, biopharmaceuticals and medicine
- mining, natural resources and the environment
- advanced materials and manufacturing
- telecommunications and information technology.

Initiatives are under way to ensure maximum western participation in the CLS. The Alberta Synchrotron Institute, a multi-level government partnership with Alberta universities, will ensure that Alberta academics and industry scientists maximize the use of the CLS, and that the province can share in the economic benefits the institute will provide to western Canada. In Saskatchewan, efforts are under way to maximize the participation of local firms in the supply of goods and services to the CLS. WD is both an advocate and funding partner for the CLS.

Enhancing Technology Commercialization Activities and Linkages

WD's mandate is "to promote the development and diversification of the western Canadian economy." While broad in scope, many of WD's investments promote the commercialization of technology. Support has been made to organizations that directly commercialize technology such as the Technology Commercialization Offices at Alberta's major universities, initiatives such as InnoCentre Alberta, and innovation centres that foster technological innovation and stimulate the commercialization of technology. The majority of clients are emerging knowledge-based businesses and technology small and medium-sized enterprises (SMEs). Support to demonstration projects in key sectors such as telehealth and climate change technologies has led to increased technology commercialization.

WD places a priority on encouraging organizations to collaborate on innovation initiatives. WD is a founding sponsor of the WestLink Innovation Network, a not-for-profit organization that facilitates communication, collaboration, and technology development and commercialization among 13 western Canadian universities, and three Networks of Centres of Excellence and their affiliated research institutions. WestLink helps members to address common technology transfer issues, to develop their skills and develop linkages to partner researchers, and to address strategic gaps through innovative, collaborative programs and services. The WestLink Technology Commercialization Internship Program (TCIP) focusses on developing technology commercialization and management skills in western Canada. Twenty interns with backgrounds in science and business are receiving intensive training and networking. A two-year internship, with three eight-month placements, will provide experience in university technology commercialization offices, start-up technology firms and venture capital firms. WD, the Natural Sciences and Engineering Research Council of Canada, the Canadian Institutes of Health Research and provincial governments are funding partners of the TCIP.

WD is the federal partner in TRLabs, Canada's largest not-for-profit applied telecommunications research consortium, with laboratories in Edmonton, Calgary, Regina, Saskatoon and Winnipeg. TRLabs is doing pre-competitive research in network systems, network access, fibre optics and photonics, data networking and wireless communications. Collectively, TRLabs is providing an environment by which highly capable faculty and students develop their abilities and then transfer their skills, knowledge and ideas to new endeavours. Through WD's support to TRLabs, small business associates have access to skilled labour and precompetitive research in the telecommunications sector.

Enhancing Firms' Capacity to Develop and Adopt New Technologies

WD's Western Canadian Business Service Network offers business counselling and targeted support programs to SMEs through 100 points of service in western Canada. Specialized services for the technology sector include the following:

- WD's Loan/Investment Fund program is a public/private partnership that provides loans and counselling services to firms and entrepreneurs in key growth areas. WD provides loan loss reserves to leverage private sector investment in higher risk, emerging small businesses. Since 1996, WD has leveraged $133 million in commitments from financial institutions for knowledge-based funds and $67.5 million in loans to SMEs in knowledge-based growth industries such as biotechnology, health technologies, information technology and telecommunications, advanced materials and advanced manufacturing technologies.
- The First Jobs in Science and Technology program is targeted at providing technology skills for SMEs and valuable work experience for new graduates. Since 1997, this program has resulted in over 735 jobs throughout western Canada, with the majority in technology sectors.
- WD sponsors a specialized service for western SMEs to assist them in deciding whether to develop a technology for commercialization. During the pilot phase, 137 western firms were able to obtain an independent assessment of their technology through the Canada Innovation Centre Technology Assessment Program, thus resulting in more informed decisions.
- Building on the earlier success of the introduction of advanced computer-aided-design and computer-aided-engineering tools at the Industrial Technology Centre (ITC), the Manitoba Virtual Reality Research and Innovation Centre will provide a leading-edge innovation service for Manitoba companies. This virtual reality centre will give Manitoba industry a competitive edge through the use of visualization

technology to improve product design and lower costs, and will give engineers the ability to design, test and simulate in an interactive 3D environment. The ITC will team up with Silicon Graphics, the global supplier of high-performance interactive computing systems, to establish the centre. Silicon Graphics will provide the technical expertise and the Centre's super-computer system. The company is renowned for its high-performance computers that produced the special effects images in *Star Wars, Episode One: The Phantom Menace* and *Jurassic Park*. WD, in partnership with the Province of Manitoba and the ITC, provided funding for this facility.

Enhancing Coordination and Alignment of Innovation Priorities and Strategies Between Federal, Provincial and Other Innovation Players

WD has brought together two groups to discuss issues of importance to western Canada:

- The Deputy Minister of Western Diversification chairs a forum of western provincial economic development deputies, to share information and explore opportunities for joint action on a range of policy issues facing the West. Increasingly, these issues are related to innovation such as access to early stage capital for technology firms, spending on R&D, and clusters.
- The Senior Officials Forum on Innovation consists of membership at the assistant-deputy-minister level or equivalent. Members come from WD, the National Research Council, Industry Canada, and the provincial/territorial jurisdictions of Manitoba, Saskatchewan, Alberta, British Columbia, the Northwest Territories and the Yukon. Senior Officials have identified a number of joint priorities, including:
  - Technology commercialization, incubation, early-stage capital, patient capital, skilled workforce;
  - S&T infrastructure and medical/health infrastructure in western Canada, enhancing capacity and linkages;
  - R&D funding; and
  - Sectors including fuel cells, genomics/proteomics, health industries/telehealth, new media and microsystems (nanotechnology).

Looking Toward the Future

As WD continues its work of strengthening the western innovation system, new challenges and areas of priority will arise. These may include assistance to rural and northern communities in facing challenges due to a reliance on a resource-based and service economy, strengthening linkages between institutions and industry, addressing skilled workforce issues, facilitating early stage investment for technology firms, promoting an innovative economy, and opportunities in sectors such as health.

Contact Information

Western Economic Diversification
Tel.: 1-888-338-9378
Web site: **http://www.wd.gc.ca**

NOTES