SCIENCE AND TECHNOLOGY ADVICE: A FRAMEWORK TO BUILD ON

A Report on Federal Science and Technology — 2002

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The following acronyms and abbreviations are used throughout this report:

ACST	Advisory Council on Science and Technology
CBRN	Chemical, biological, radiological and nuclear
CCEU	Cabinet Committee for the Economic Union
CCMD	Canadian Centre for Management Development
CFI	Canada Foundation for Innovation
CFS	Canadian Forest Service
CIHR	Canadian Institutes of Health Research
COSO	Committee of Senior Officials
CRTI	The Chemical, Biological, Radiological and Nuclear Research and Technology Initiative
CSTA	Council of Science and Technology Advisors
FINE	Federal Innovation Networks of Excellence
HR	Human resources
IP	Intellectual property
IRAP	Industrial Research Assistance Program
ISO	International Organization for Standardization
MOU	Memorandum of Understanding
NGOs	Non-government organizations
NSERC	Natural Sciences and Engineering Research Council of Canada
PERD	Program of Energy Research and Development
R&D	Research and development
RSAs	Related scientific activities
S&T	Science and technology
SAAC	Science Assistant Deputy Ministers' Advisory Committee
SABs	Science advisory bodies
SBDAs	Science-based departments and agencies
SMEs	Small and medium-sized enterprises
SSHRC	Social Sciences and Humanities Research Council of Canada

Innovation, creativity and knowledge are keys to success in today's world. Recognizing this, the Government of Canada has challenged Canadians to position our country among the top five nations in the world for research and development and for marketing new products and services by 2010.

When we launched *Canada's Innovation Strategy* in February 2002, we identified a number of targets to attain this goal. We recognized that achieving these targets requires investing in research and development and working in partnerships with universities and the private sector to develop commercialization strategies. We have taken action.

At the National Summit on Innovation and Learning in Toronto this past November, we identified Government of Canada initiatives to build momentum and address these targets:

- the revitalization of the Prime Minister's Advisory Council on Science and Technology;
- a Framework of Agreed Principles with the Association of Universities and Colleges of Canada who, in representing the country's research universities, will commit universities to doubling the amount of research they perform and tripling their commercialization performance; and
- the creation of an External Advisory Committee on Smart Regulation whose responsibilities will include reviewing the Government of Canada's regulatory framework for new drug approvals, having copyright regimes that give better support to investments in culture, and making the environmental approval process more transparent and effective.

Science and technology in the Government of Canada are an essential and integral part of the national innovation system. Over time, the roles and interaction of federal departments and agencies with our partners in the innovation system have evolved. We must continue to make progress.

This report, *Science and Technology Advice: A Framework to Build On*, demonstrates the vitality of federal science and technology. It shows how the government is taking action on the science and technology policy advice it receives and making the best possible use of it. It maps the progress we have made in the development of a government-wide framework for improving the use of science and technology advice in government decision making.

The Government of Canada's work in science and technology encompasses a wide range of activities with a common driving force: the best available knowledge to answer questions, to inform decision making and to build an innovative nation. These efforts contribute to an environment of prosperity that will enable all Canadians to benefit from our shared goals of economic growth and job creation, top quality health care, excellence in education for our young people, and vibrant communities in which to live, learn and grow.

Allan Rock
Minister of Industry

Science and Technology Advice: A Framework to Build On highlights the important roles that the Government of Canada's science and technology activities play in issues that matter to Canadians. Whether it is the safety of our food, the development of cleaner fuels, or debates about human cloning, the Government of Canada's science community is an important contributor to the policy decision-making processes that shape the lives of Canadians.

As Secretary of State (Science, Research and Development), I see the interactions between science and policy on a regular basis and am confident in my reassurance to Canadians that the quality of scientific and technological advice that is being given is truly world-class. Indeed, all Canadians can be proud of the system that produces it.

Federal science and technology work encompasses a wide range of activities, from understanding the origins of the universe to predicting the weather to developing surveillance systems for infectious diseases. In all of these activities, however, the driving force is the same: the best available knowledge to answer questions and inform decision-making.

For this reason, we must continue to work together to eliminate the institutional barriers between government science, university science, and private sector science, for all the players in our innovation systems need to work together to provide a better quality of life for Canadians. Networks, partnerships and collaborations should not be moulded by government policy — they should be driven by shared needs and objectives.

Science and Technology Advice: A Framework to Build On does indeed provide a basis on which we can continue to add to the tools and skills necessary to participate fully in a dynamic economy both in Canada and throughout the world. This in turn will ensure a more sustainable economic, environmental and social future for all Canadians.

Rey Pagtakhan
Secretary of State
(Science, Research and Development)

INTRODUCTION

1.1. FOREWORD

This report, covering the year 2002, is the fifth in a series of reports that have been issued since the release of the Government of Canada's 1996 science and technology (S&T) strategy, *Science and Technology for the New Century*. Last year's report, *Investing in Excellence*, was a special edition, providing a five-year retrospective on the implementation of the strategy. It concluded that the strategy's principles had 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.

As with last year's report, this one is a collaborative effort, involving 22 science-based departments and agencies (SBDAs). Both the body of the report and the appendix highlight the adoption of the Framework for S&T Advice.

1.2 THE 2002 REPORT ON FEDERAL S&T

This year's report reviews the activities of the federal science and technology community during 2002 and describes major developments that influenced it during the year. The report is organized into four chapters and an appendix:

- **Chapter 1** sets out the more recent context that continues to shape federal S&T. Topics covered include the launch of *Canada's Innovation Strategy* and the subsequent National Summit on Innovation and Learning, the last Speech from the Throne, the recent Federal Science and Technology Forum, and the Federal Innovation Networks of Excellence initiative.
- **Chapter 2** provides the historical development and recent projects of governance groups, including the Advisory Council on Science and Technology, the Council of Science and Technology Advisors, and the Federal S&T Community Management Secretariat.
- **Chapter 3** profiles the work of the Canadian government in developing and adopting its Framework for Science and Technology Advice.
- **Chapter 4** examines the statistics of Government of Canada investments in S&T. In particular, it examines national

and federal progress towards the targets set out in the *Innovation Strategy* document, *Achieving Excellence: Investing in People, Knowledge and Opportunity.*

- **The appendix** allows the 22 SBDAs to present highlights of their performance and achievements during 2002. Where appropriate, they report on steps taken to implement the Framework for Science and Technology Advice, for policy and regulation development and decision making.

1.3 *CANADA'S INNOVATION STRATEGY*, FEBRUARY 2002 — ACHIEVING EXCELLENCE

The strong commitments to research and development (R&D) and innovation underlined in the 2001 Speech from the Throne were reiterated in *Canada's Innovation Strategy*, launched jointly by Industry Canada and Human Resources Development Canada in February 2002. The Government of Canada introduced several new goals to make Canada a global leader in innovation performance by the end of the decade. Those that relate to S&T include:

- doubling the Government of Canada's present funding for R&D by 2010;
- strengthening the capacity of Canadian university and government labs and institutions to carry out research activities; and
- accelerating Canada's ability to bring research discoveries out of our laboratories and into the marketplace.

Following the launch of *Canada's Innovation Strategy*, the government undertook a major engagement process, involving regional and sectoral summits, that culminated in the National Summit on Innovation and Learning in Toronto, in November 2002. Canadians were invited to share their views and help develop a national innovation and learning action plan to improve innovation performance across all sectors of the economy.

1.4 SPEECH FROM THE THRONE, SEPTEMBER 2002 — *THE CANADA WE WANT*

The 2002 Speech from the Throne, *The Canada We Want*, continued to build on the theme of innovation and its role in building a strong economy. It recognized that the fuel of the new economy required to make Canada a world leader in innovation is knowledge. The speech placed particular emphasis on skills, learning and research across government and academe, and among small and medium-sized enterprises (SMEs).

The Speech also highlighted the government's intention to strengthen government science by integrating efforts across departments and disciplines to better focus on the priorities of Canadians. There were direct references to the challenges of climate change and the environment, as well as those of Canada's urban, rural and northern communities. Also, the Speech noted that issues such as wilderness and habitat conservation, ecological integrity, and water and air quality rely greatly on the contribution of government S&T.

The Canada We Want also emphasized the government's commitment to increase its support for graduate studies and research through the granting councils,[1] and to work with universities to address the indirect costs of both research and strategies for the commercialization of their research. Of equal

1. Canada's three granting councils are the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada, and the Canadian Institutes of Health Research.

importance, the government is continuing to work with SMEs to nurture the development and application of new technologies across traditional and emerging sectors.

The Government of Canada is committed to working with partners and individual Canadians to develop and put in place a national innovation action plan to brand Canada as one of the most innovative economies in the world. Through multi-stakeholder gatherings such as the National Summit on Innovation and Learning, the Government of Canada is seeking to position Canada as a world leader in such areas as health sciences, biotechnology, and clean energy.

Recognizing that a knowledge economy also requires a reshaping of the regulatory approach, the Speech from the Throne outlined the government's commitment to move forward with a smart regulation strategy. The Speech noted the government's intention to create an External Advisory Committee on Smart Regulation to recommend areas where regulatory redesign is needed to create and maintain a Canadian advantage. Of relevance to S&T, reform is being accelerated in key areas such as health and sustainability. The Government of Canada is working with provinces to implement a national system for the governance of research involving humans, and is reintroducing legislation to amend the *Canadian Environmental Assessment Act.*

1.5 THE NATIONAL SUMMIT ON INNOVATION AND LEARNING

Background

The National Summit on Innovation and Learning, sponsored by the ministers of Industry and Human Resources Development, was held in Toronto, November 18–19, 2002. The objective of the national summit was to engage partners from the private sector, non-government organizations (NGOs), academia and government in shaping the priorities for *Canada's Innovation Strategy*, and to seek commitment from all sectors for a Canadian innovation and learning action plan.

The summit was the culmination of a seven-month, country-wide engagement process that involved the participation of more than 10 000 Canadians who attended regional summits, sectoral meetings, expert round tables and best-practice workshops to discuss *Canada's Innovation Strategy*, as outlined in *Achieving Excellence: Investing in People, Knowledge and Opportunity* and *Knowledge Matters: Skills and Learning for Canadians*, both released in February 2002.

More than 250 written submissions were received as formal input to the engagement process, and more than 500 leaders from across the country attended the national summit. Participants were asked to identify the priority actions required by the private and public sectors to realize Canada's vision of becoming one of the most innovative and skilled countries in the world, as well as a magnet for talent and investment. The conclusions reached and advice provided regarding the implementation of priority recommendations will serve as a guide to governments, communities, educational institutions, private sector firms and other stakeholder groups, as Canada prepares to build on its past successes and address strategic gaps in its innovation and learning systems.

Outcomes

The summit produced several outcomes. In working sessions, delegates ranked the

National Summit on Innovation and Learning: Summit Themes

- Improving research, development and commercialization
- Enhancing the innovation environment
- Strengthening our learning culture
- Building an inclusive and skilled work force
- Strengthening communities.

recommendations they considered to be the most critical within the five crosscutting themes identified in the engagement process. These were put forward, together with implementation strategies, as priorities for action. The 18 priority recommendations can be viewed in the *National Summit on Innovation and Learning Summary* found at **www.innovationstrategy.gc.ca**. In panel sessions, delegates discussed challenges to innovation and learning vis-à-vis communities; immigration; life sciences, biotechnology and health innovation; and the environment and clean energy. They also made several observations regarding what is needed to improve Canada's position in these domains. In speeches delivered by the ministers of Industry and Human Resources Development, the Government of Canada stated its commitment to early actions to advance the innovation and learning strategy, and announced a series of new initiatives.

1.6 TOWARDS A SHARED VISION FOR FEDERAL S&T

In 2002, federal S&T took important strides towards more horizontal approaches to dealing with the public policy issues facing the nation. There was an increased recognition that few science-related issues these days can be addressed using only the S&T capabilities of one department. Indeed, to understand and take effective action on most public policy issues of interest to Canadians requires the participation of governments at all levels, universities and the private sector. In many cases, it is also useful, and often essential, to include international expertise and knowledge.

The Chemical, Biological, Radiological and Nuclear Research and Technology Initiative

In the wake of the terrorist attacks of September 11, 2001, the Government of Canada moved quickly to strengthen its R&D capabilities to respond to chemical, biological, radiological and nuclear (CBRN) threats. The CBRN Research and Technology Initiative (CRTI) is the federal S&T community's response. The CRTI is mandated to implement the following recommendations to improve Canada's ability to respond to CBRN incidents:

- create clusters of Government of Canada labs as elements of a federal laboratory response network that will build S&T capacity to address the highest-risk terrorist-attack scenarios;
- create a fund to build capability in critical areas, particularly those identified in the scenarios that address biological and radiological attack;
- accelerate technology into the hands of the first-responders community and other operational authorities; and
- provide funds to those areas where national S&T capacity is deficient owing to obsolete equipment, dated facilities and inadequate scientific teams.

The CRTI will strengthen the coordination and collaboration of capacity, capabilities, and research and technology plans and strategies.

The Federal Innovation Networks of Excellence

The CRTI model draws on, and will be a test case for, many of the concepts of a broader proposal — the Federal Innovation Networks of Excellence (FINE), which was developed by federal SBDAs. FINE itself was built on the principles and recommendations the government has received from one of its external advisory bodies, the Council of Science and Technology Advisors (CSTA). The CSTA called for government S&T activities based on:

- multistakeholder partnerships aimed at fulfilling national needs through the most appropriate combination of resources (government, industry, university);
- excellence assured by appropriate expert review in the selection of projects and in the assessment of results and performance;
- openness and transparency in decision making and the dissemination of results; and
- competition amongst proposals to ensure that the highest-priority issues are addressed.[2]

The FINE proposal suggested a new way for federal SBDAs to address the many pressing public policy issues that cross departmental mandates and jurisdictions. In an era when S&T considerations are increasingly important to public policy issues, the Government of Canada needs to be able to anticipate and/or react quickly to emerging multidisciplinary scientific and technological challenges and opportunities.

The FINE proposal focussed on building research networks that include not only Government of Canada departments and agencies, but also other governments (domestic and international), university researchers with complementary expertise and equipment, and private sector firms with interests in the specific research field. Through these partnerships across the innovation system, the Government of Canada would be able to apply the best available expertise to areas with high public policy relevance. The selection of network themes would be based on broad consultations and foresight processes. Excellence and relevance of the research programs and projects would be ensured through competitive, peer-reviewed selection processes.

FINE currently exists only as a concept, but its principles are influencing how the government organizes itself to deal with complex S&T-based issues. In addition to the CRTI, horizontal initiatives on issues such as water and northern S&T lend themselves to a FINE approach.

The Federal Science and Technology Forum

The FINE concept was discussed in some depth in October 2002 at the Federal Science and Technology Forum. Subtitled "Transforming Federal Science and Technology for the Future: Achieving a Vision for Excellence," the forum brought together more than 350 stakeholders to discuss future directions for federal S&T. Those in attendance included not only federal scientists, engineers and technologists, science managers and policy makers, but also representatives from academe, the private sector, the media and Canada's youth. Forum participants heard stimulating and inspirational presentations from scientists of the future — current and past winners of the Canada-Wide Science Fair.

2. Council of Science and Technology Advisors, *Building Excellence in Science and Technology (BEST): The Federal Roles in Performing Science and Technology* (Ottawa: 1999), p. 27 [Cat. No. C2-470/2000].

The forum had the following three objectives:

- to articulate a shared vision or elements of a shared vision concerning the future of federal S&T within the national system of innovation;
- to share best practices with respect to new directions in federal S&T delivery; and
- to identify actions that could guide the evolution of federal S&T efforts from 2002 to 2010.

There was general support among forum participants for the principles underlying the integrating capabilities of FINE across the innovation system, the expert review of proposals against excellence and relevance criteria, and some form of priority setting or foresight to choose emerging issues for examination. Forum participants also discussed and provided inputs into a draft vision (see box, page 11) for the future of federally performed S&T. This vision signals a desire to pursue a new future for federal S&T, one with increased emphasis on S&T in service to the interests of Canadians, teamwork, and the integration of efforts across the innovation system.

The forum generated enthusiastic and passionate discussions, as well as a wide range of ideas on how to improve the contribution of federal S&T to the well-being of Canadians. In workshops, forum participants discussed the future under the following four headings:

- Innovation in the Delivery and Management of Federal S&T;
- Ensuring Federal S&T Excellence;
- Integrating Science and Policy; and
- Transforming the Management of Federal S&T Human Resources.

These workshops generated themes for discussion during the rest of the forum, which in turn gave rise to more than 85 suggestions for action. In response to the forum, Government of Canada departments and agencies, individually and collectively, have committed to action in the following areas:

- governance and management;
- knowledge management;
- human resources;
- communications; and
- excellence.

In addition, three regional fora are planned to bring a regional perspective to making the vision a reality.

Themes that ran through all of these discussions and action plans included:

- collaboration among departments and agencies to address key public policy issues;
- better communication linkages between scientists and policy makers;
- a commitment to communication with external stakeholders and all Canadians; and
- concerted efforts to improve the image of the Government of Canada as an S&T employer of choice.

The forum sent a clear message that the Framework for Science and Technology Advice should be fully implemented by departments. The forum was organized by Government of Canada departments and agencies, and was coordinated and

A Vision for Canadian Government Leadership in Science and Technology: Working Together for Science Excellence and Service to Canadians

The Canadian federal Public Service will enhance its research, development and scientific services in order to secure Canada's place as a world leader in innovation, opportunity and quality of life.

The Government of Canada's S&T efforts will identify emerging issues that matter to Canadians and refocus in response to changing needs in areas such as health and safety, public security, natural resources and the environment, and the growth of the knowledge economy.

Federal scientists will mobilize science resources in the search for innovative and lasting solutions to the challenges ahead. They will sustain their efforts until solutions are found and adopted.

Recognizing that teamwork sparks creativity and improves the use of resources, the Public Service will better integrate its scientific activities across departments and disciplines, including the natural and social sciences and policy analysis. It will also build more research teams with partners such as Canadian universities, industry and scientific institutions in other countries. And it will work with the private sector to develop knowledge and technologies that serve the greater public good.

These combined efforts will contribute consistently to the development of better policies and the delivery of superior services throughout the Government of Canada.

The Public Service values its outstanding scientists, engineers and technologists, and will invest the resources necessary to attract, develop and support them in the performance of consistently excellent work.

Federal scientists will build on their reputation as prime sources of credible, useful and trusted information for Canadians, because science is valued by Canadians and should be part of everyday life in a confident and successful nation.

supported by the S&T Community Management Secretariat. The forum recommendations and action plan were discussed and approved by the deputy minister-level Committee of Senior Officials (COSO) Science and Technology Subcommittee.

1.7 OTHER RELEVANT DEVELOPMENTS

The Framework for Science and Technology Advice

The role of federal S&T continues to be a critical factor in securing the economic and social well-being of Canadians. The Government of Canada's Framework for Science and Technology Advice (May 2000) recognized S&T as an essential part of policy development. This past year, science and policy communities across federal SBDAs have been working towards the implementation of the Framework. The development and enhancement of mechanisms to facilitate a stronger consideration of science-based evidence in decision making has been among their priorities. Federal S&T will better inform policy, while timely and sound federal S&T advice will further enrich decision making in the interest of the public good.

Ratification of the Kyoto Protocol

Federal S&T advice better prepares decision makers as they address the pressing issues of the day. One such example is the ratification of the Kyoto Protocol, one of several Government of Canada commitments calling for the continued contribution of federal S&T. In November 2002, the Government of Canada released the Climate Change Plan for Canada, and ratification quickly followed on December 16, 2002. The

Kyoto ratification calls upon the stewardship of federal S&T as the Government of Canada seeks to reduce Canada's greenhouse gas emissions to six percent below 1990 levels by 2012. To this end, the government is moving forward to implement its Climate Change Plan, in which innovation and technology have been identified as key to the long-term solutions to climate change. Working with industry, academe and other public organizations, federal S&T is playing an important role in advancing S&T knowledge to support sustainable decision making.

Kyoto Adaptation Strategies in the Forest Sector

The Intergovernmental Panel on Climate Change and an international working group of climate change scientists are confident that global warming is occurring and that at least some of it is due to human activity. The predicted levels and rates of climate change could have serious ecological and socio-economic implications for Canadian forests. Furthering our knowledge of those impacts will ensure that we are better able to develop strategies for mitigating or adapting to the changing conditions.

Research by Natural Resources Canada's Canadian Forest Service (CFS) has led to the development of the Carbon Budget Model of the Canadian forest sector, making Canada a leader worldwide in assessing forest carbon budgets on a national scale. Now the CFS is turning its attention to applying the model on provincial and even local scales to provide policy makers with the information they need to make wise forest management planning decisions that will help future forests and the environment in which they grow.

SCIENCE AND TECHNOLOGY GOVERNANCE

The federal S&T strategy, *Science and Technology for the New Century*, noted that Canada has numerous sources available for advice on S&T. It called for better mechanisms to focus and transmit that advice to decision makers.

Since the release of the strategy, the Advisory Council on Science and Technology (ACST) has been created and has provided the government with expert advice on the S&T issues facing our nation. The Council of Science and Technology Advisors (CSTA) was created during the same period and has had a significant impact on the management of S&T within the Government of Canada.

Cross-government issues related to S&T human resources (HR) are being dealt with from a "community of interest" perspective by the federal S&T Community Management Secretariat.

2.1 ADVISORY COUNCIL ON SCIENCE AND TECHNOLOGY

The ACST is made up of 13 prominent Canadians in the S&T field, with the Minister of Industry as Chair, and the Secretary of State for Science, Research and Development as Vice-Chair. Operational leadership is provided by a deputy chair from outside government.

The ACST was established in 1996 to serve as the cornerstone of the government's S&T strategy, *Science and Technology for the New Century*. The ACST has a mandate to provide the government with strategic advice on research and S&T and innovation issues, as well as to identify emerging issues and advise on a forward-looking agenda.

The ACST has completed three studies commissioned by the Cabinet Committee for the Economic Union (CCEU) using expert panels (i.e. groups of outside experts who were chaired by a member of ACST):

- *Public Investments in University Research: Reaping the Benefits*, a report of the Expert Panel on the Commercialization of University Research released in May 1999, examines the commercialization of university research and explores the options for maximizing the economic and social benefits to Canada from public investment in university research. In the report, the Expert Panel called for coherent intellectual property policies in Canadian universities, adequately resourced university commercialization offices, competitive business conditions, and increased investments in university research.

- *Stepping Up: Skills and Opportunities in the Knowledge Economy,* a report of the Expert Panel on Skills released in March 2000, addresses fundamental skill challenges that apply to five knowledge-intensive sectors of strategic importance to Canadian industry, namely, aerospace, automotive, biotechnology, environmental technology, and information and communications technology. The Expert Panel called for Canada to create more opportunities for Canadians to put their skills to work. The report emphasizes the need to improve the functioning of Canada's labour markets; to leverage Canada's R&D capacity to create new opportunities for employment; to strengthen learning systems; and to improve the efficiency of "school-to-work-to-school" transitions. In the report, the Expert Panel also called for the completion of national telecommunications infrastructure, and challenged industry, governments, the education and training sector, and individual Canadians to develop an entrepreneurial culture in Canada.

- *Reaching Out: Canada, International Science and Technology, and the Knowledge-based Economy*, a report of the Expert Panel on Canada's Role in International Science and Technology released in October 2000, explores ways to maximize the benefits of international S&T cooperation and promote Canada's international image as a leading innovative nation in today's global knowledge-based economy. The Expert Panel concluded that Canada needs to strengthen its policy framework for involvement in international science and technology; create an efficient mechanism for coordination within the federal government; and ensure an appropriate level of investment across all sectors.

In addition, in May 2000, the Prime Minister's Office commissioned the ACST to examine the role of the Government of Canada in supporting the indirect costs of federally sponsored university research. The report, *Creating a Sustainable University Research Environment in Canada*, addresses the relative importance of universities to Canada's R&D efforts in comparison with other countries. In the report, the ACST underlined the need to effectively support Canada's university research system, which includes the associated hospitals and research institutes, in order to ensure that Canadian universities can make their full contribution to our economic and social future. The ACST also recommended that the Government of Canada create a permanent program to support the indirect costs of university research in proportion to the amount of funding for the direct costs of research that it provides to universities through the Canadian Institutes for Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada. All ACST studies have been made public and are available on the Council's Web site (**http://acst-ccst.gc.ca**).

The ACST has been an important instrument of policy-making advice for the government. Many of the ideas in their four reports have been incorporated into the *Innovation Strategy* and recent government initiatives, including:

- funding for indirect costs;
- increased support for graduate students;

- more flexible immigration regulations to attract highly qualified people;
- a commercialization strategy with universities;
- increased funding for the Canada Foundation for Innovation (CFI) for international collaborative scientific research; and
- increased funding for the National Research Council Canada's Industrial Research Assistance Program.

The Minister of Industry has asked the ACST to provide advice on the way forward for research and innovation in the period after the Summit on Innovation and Learning.

2.2 COUNCIL OF SCIENCE AND TECHNOLOGY ADVISORS

The CSTA is an external, expert advisory body that provides advice to the CCEU on the strategic management of the Government of Canada's internal S&T enterprise. The CSTA was created in 1998, in response to the 1996 federal S&T strategy, *Science and Technology for the New Century*, which called for greater government reliance on external advice.

CSTA membership is drawn from the academic, private and not-for-profit sectors, and reflects the diversity of S&T-based disciplines. Council members are nominated by federal SBDAs, which draw nominees from their respective departmental science advisory bodies (SABs). The CSTA draws these advisors into a single body to improve federal S&T management by examining issues common across SBDAs and highlighting opportunities for synergy and joint action. The CSTA is chaired by the Secretary of State for Science, Research and Development.

Since its inception in 1998, the CSTA has addressed a number of issues related to federal S&T governance, exploring these issues in a series of reports delivered to the CCEU and subsequently released to the public. In its first report, *Science Advice for Government Effectiveness (SAGE)*, in 1999, the CSTA recommended a set of principles and guidelines for the effective use of science advice in the Government of Canada's decision-making process, recommending that the government employ measures to ensure the quality, integrity and objectivity of its S&T. The government's response to the *SAGE* report was entitled *A Framework for Science and Technology Advice: Principles and Guidelines for the Effective Use of Science and Technology Advice in Government Decision Making*.

In its second report, *Building Excellence in Science and Technology (BEST)*, also in 1999, the CSTA addressed the roles of the Government of Canada in performing S&T, and its capacity to deliver on these roles. The report described the fundamental principles that should be applied to the conduct of federally performed and funded S&T, including alignment, linkages and excellence. The CSTA concluded that the Government of Canada must maintain a strong in-house S&T capability to ensure the present and future well-being of Canada, its people and its environment.

In *Science and Technology Excellence in the Public Service (STEPS)*, in 2001, the CSTA presented a framework for excellence in government S&T built on a foundation of four essential conditions (leadership, management, capacity and science-policy interface) and four pillars that define the elements of federal S&T excellence

In its report *Employees Driving Government Excellence (EDGE)*, the CSTA recommends that the Government of Canada:

- ensure clear departmental S&T mandates and communicate these mandates to departmental employees and potential new recruits;
- support and properly fund an S&T community organization to monitor and forecast labour market conditions and to benchmark the Government of Cananda against other sectors and countries in areas such as work conditions and compensation;
- support SBDAs in strategically planning their HR strategies and in ensuring that they are competitive in the S&T labour market;
- dramatically shorten the time required to hire new employees;
- target the recruitment of young S&T workers while they are still students and research trainees, and encourage and fund the staffing of postdoctoral scientists;
- create a better balance in the system between term and indeterminate employees through flexibility and by ensuring that term employment is used only in appropriate situations;
- allow Canadians residing outside Canada easier access to federal S&T job competitions, to facilitate the recruitment of skilled Canadians back to Canada from abroad;
- provide significant opportunities for training to support lifelong learning and career development;
- foster greater mobility both within government and with industry and academia, by enhancing programs such as interchanges, and removing structural barriers that inhibit the flow of individuals;
- decentralize HR functions to empower science managers, allowing them greater discretion and accountability; and
- foster an open environment where managers and employees can share information about retirement and restaffing plans, so that managers can approach restaffing strategically and ensure that bridging plans are in place to facilitate knowledge transfer.

(quality, relevance, transparency and openness, and ethics). In *Reinforcing External Advice to Departments (READ)*, 2001, the CSTA identified a series of characteristics and practices to maximize and capitalize on the contribution of the SBDAs' external science advisory bodies.

In all of these reports, the CSTA identified HR as one of the most critical challenges facing federal S&T. In June 2001, the government asked the CSTA to expand on its previous work by conducting an examination of the challenges unique to the renewal of federal S&T personnel and recommending policies and practices to address these challenges. The CSTA responded by preparing the report *Employees Driving Government Excellence: Renewing S&T Human Resources in the Federal Public Service (EDGE)*. This report was released in November 2002.

In *EDGE*, the CSTA maintains that if Canada is to realize its goal of ranking among the world's top five R&D performers, the Government of Canada must fulfill its role in the national innovation system. To effectively fulfill its role, the government requires a dynamic, high-calibre internal S&T work force. Thus, the government must act decisively to address its S&T HR challenges, ensuring a competitive working environment supported by HR policies and practices that are conducive to the conduct of modern science.

EDGE begins by examining the evolving context in which the government conducts its S&T, noting the accelerating advances in S&T and the demographic shifts that are occurring in Canada and western economies more broadly. The report also notes the implications of the government's own commitment to make

Canada one of the world's top five R&D performers by 2010. The report looks at distinguishing characteristics of the federal S&T community, examining the ways in which it is different from S&T workers in the broader Canadian labour market and from federal public servants as a whole. *EDGE* goes on to examine the demographics of federal S&T workers in the context of the overall labour market, looking at factors such as recruitment and departure statistics.

The report also identifies four foundations that the CSTA feels must be in place if the Government of Canada is to achieve excellence in its S&T HR system: leadership, management, opportunity, and legislative and policy structure. The report examines the barriers in the current federal HR system in four major dimensions: evaluation of supply and demand conditions, attraction and recruitment, maintenance and retention, and retirement. These dimensions are not unique to the S&T community, but are considered with the special characteristics of the S&T community in mind. The CSTA concludes that success in solving the government's S&T HR challenges requires efforts related to all four of these dimensions. In each of these areas, the government must eliminate practices and procedures that are not consistent with a healthy work environment and not conducive to the practice of modern science.

At a December 16, 2002, meeting, the COSO S&T Subcommittee decided that the Science Assistant Deputy Ministers' Advisory Committee (SAAC) would provide a response to the CSTA's *EDGE* recommendations in 2003.

The CSTA is currently completing work on a report that examines the unique challenges facing the Government of Canada with respect to communicating its S&T, and that provides recommendations to improve the effectiveness of federal S&T communications. The report addresses the importance of communicating federal S&T and the benefits that accrue for both government and society; the challenges of communicating federal S&T; the foundations and principles that support effective government S&T communications; and guidelines to inform development of departmental S&T communications strategies.

The CSTA's reports, as well as supporting documentation, can be found on the CSTA Web site (**www.csta-cest.ca**).

2.3 THE FEDERAL S&T COMMUNITY MANAGEMENT SECRETARIAT

The federal S&T community is made up of more than 22 000 employees from numerous government departments and agencies with distinct mandates and specializations, all united by their need for skilled, committed and innovative S&T professionals.

The goal of the federal S&T community is to foster a work environment that will continue to attract and retain first-rate S&T professionals. The Federal S&T Community Management Secretariat supports the community as it works toward this goal by developing, implementing, monitoring and evaluating numerous initiatives and pilot projects.

Background

In 1994, the Auditor General of Canada and the CCEU recognized that the S&T community was a "community at risk." As a result, a Framework for the Human Resources Management of the Federal Science and Technology Community was adopted to help the government develop and implement policies and tools that science managers could use to align their organizations with the federal direction in science.

The SAAC, with membership from SBDAs, central agencies and the Professional Institute of the Public Service of Canada, was struck to address the recommendations of the Framework and to provide direction for HR renewal. The SAAC reports to an S&T subcommittee of COSO, which is composed of deputy ministers and chaired by the champion for the S&T functional community.

The COSO S&T Subcommittee identified several key priorities to enhance HR management at a community-wide level and raise awareness of the S&T community. These priorities form the basis of the strategic plan developed by science assistant deputy ministers (ADMs) and the SAAC. Key among the strategic objectives are the themes of recruitment and retention, learning and communications. These strategic objectives are the foundation for S&T Community Management Secretariat activities.

In addition, communications and marketing strategies and initiatives were developed to raise awareness and promote federal S&T organizations, and to enhance a sense of community with the S&T work force through engagement and communications. The external and internal S&T community Web sites were redesigned and launched. These Web sites provide managers, employees and the Canadian public with information on the S&T community; market federal S&T organizations; and enhance a sense of community within the current S&T work force.

The S&T community developed longer-term recruitment strategies and initiatives at the community level. Under the Graduate Opportunities Strategy, 96 people were recruited in federal S&T positions, in seven departments and agencies. Also, a business case was prepared on a strategy for the recruitment of persons with disabilities. It includes the commitment to hire three students per year (minimum) and to develop a marketing and communications strategy to promote the program. Furthermore, the Aboriginal Youth Initiative was promoted.

The S&T community also developed and implemented career development programs to address the unique needs of science managers. In partnership with the Canadian Centre for Management Development (CCMD), the Leading Scientific Teams workshop was developed and piloted. Also, four regional science manager fora were held on the following topics:

- science centres of excellence;
- innovation and new attitudes in science and emerging technologies;
- areas of competence for the S&T community;
- funding science;
- fostering cooperation between universities and Government of Canada research laboratories in conducting scientific studies; and
- HR problems facing government science and knowledge management.

In June 2001, the S&T community co-located the Federal Science and Technology Community Management Secretariat with the deputy minister champion for the S&T functional community. In addition to providing support to the SAAC and the COSO S&T Subcommittee, the Secretariat coordinates the development of community-wide HR plans, programs and activities, in support of the S&T community strategic objectives.

The Federal Science and Technology Community Management Secretariat has played an expanded role over the past year, supporting the development of FINE and contributing to the development of a new shared vision for federal S&T by organizing and hosting the 2002 Federal Science and Technology Forum, in partnership with CCMD.

The S&T Secretariat continues to provide ongoing sustainable HR management for the S&T functional community by providing input to government-wide HR initiatives to convey the community's vision, perspectives and needs for a modern and flexible HR regime. It also reports achievements to central agencies and the Clerk of the Privy Council, and provides input to reports on S&T. The Secretariat will lead the government-wide response to the CSTA's *EDGE* report.

Communications activities will continue to focus on building a sense of community within the S&T work force, promoting federal S&T careers, and building strong linkages with the federal regional science councils.

Recruitment initiatives will continue to emphasize employment equity, and will define recruitment processes and programs to assist S&T managers in attracting and recruiting in an expeditious and efficient manner within the values and principles of the Public Service.

IMPLEMENTING THE FRAMEWORK FOR SCIENCE AND TECHNOLOGY ADVICE

The emergence of the knowledge-based society has underscored the importance of sound S&T advice as a key input to policy formulation both nationally and internationally.[3,4] The effective use of S&T advice serves Canada's interests in areas such as food safety, environmental protection, public health and safety, sustainable development, innovation, and national security.[5]

This chapter profiles the work of the Canadian government in developing and adopting its Framework for Science and Technology Advice.

3.1 DEVELOPING THE FRAMEWORK FOR SCIENCE AND TECHNOLOGY ADVICE

In 1998, the CCEU asked the CSTA to develop a set of principles and guidelines for the effective use of science advice in making policy and regulatory decisions.

Informed by similar efforts in the United Kingdom and other countries, and by the best practices existing in Canadian government departments and agencies, the CSTA's report, *Science Advice for Government Effectiveness (SAGE)*[6] provided the basis for the development of the Government of Canada's *Framework for Science and Technology Advice: Principles and Guidelines for the Effective Use of Science and Technology Advice in Government Decision Making.*

The Framework consists of two key parts: the six principles (see box, page 20), each with a number of interpretative guidelines, and 10 implementation measures organized around three themes (promoting Framework adoption, ensuring accountability and evaluating effectiveness).

The principles and guidelines address how S&T advice should be sought and applied to enhance the government's ability to make informed decisions. The implementation measures ensure the effective adoption of and accountability for the principles and guidelines.

In many ways, the Framework for Science and Technology Advice is analogous to an International Organization for Standardization (ISO) quality-management standard. The Framework principles and guidelines establish a benchmark against which to test the robustness of S&T advisory processes.

3. Kevin Keough, "Science Advice for Government Effectiveness: The Canadian Approach," *The IPTS Report*, Vol. 45 (June 2000) (Seville: Institute for Prospective Technological Studies).

4. J. Kinder, Cathy Rudick and Karen Brown, "Implementing the Framework for Science and Technology Advice in Canadian Government," *The IPTS Report*, Vol. 60 (December 2001) (Seville: Institute for Prospective Technological Studies).

5. *A Framework for Science and Technology Advice: Principles and Guidelines for the Effective Use of Science and Technology Advice in Government Decision Making* (Ottawa: Industry Canada, 2000). **http://strategis.gc.ca/pics/te/stadvice_e.pdf**

6. Council of Science and Technology Advisors, *Science Advice for Government Effectiveness (SAGE)* (Ottawa: 1999). **http://csta-cest.gc.ca/pdf/sage_e.pdf**

Framework for Science and Technology Advice Principles

Principle I: ***Early Issue Identification***

The government needs to anticipate, as early as possible, those issues for which science advice will be required, to facilitate timely and informed decision making.

Principle II: ***Inclusiveness***

Advice should be drawn from a variety of scientific sources and from experts in relevant disciplines, to capture the full diversity of scientific schools of thought and opinion.

Principle III: ***Sound Science and Science Advice***

The government should employ measures to ensure the quality, integrity and objectivity of the science and science advice it uses, and ensure that science advice is considered in decision making.

Principle IV: ***Uncertainty and Risk***

Science in public policy always contains uncertainty that must be assessed, communicated and managed. Government should develop a risk management framework that includes guidance on how and when precautionary approaches should be applied.

Principle V: ***Transparency and Openness***

The government is expected to employ decision-making processes that are open, as well as transparent, to stakeholders and the public.

Principle VI: ***Review***

A subsequent review of science-based decisions is required to determine whether recent advances in scientific knowledge have an impact on the science advice used to reach the decision.

3.2 ADOPTING THE FRAMEWORK

Adopting the Framework requires aligning advisory processes and practices to the principles and guidelines, and undertaking necessary initiatives in keeping with the implementation measures. The adoption process has proceeded along two tracks: within each government department and across the government.

Those departments and agencies that are required to make decisions on complex policy and regulatory issues where S&T is a key factor are most affected by the Framework. As such, they need to demonstrate that government decisions are informed by sound S&T advice. However, each SBDA is given flexibility in adopting the Framework, due to the diversity of their science, policy and regulatory functions.

How each individual department has undertaken the adoption of the Framework is detailed in the Appendix at the end of this report.

This section primarily focusses on the interdepartmental actions taken to respond to the Framework implementation measures. Recognizing an opportunity for SBDAs to collaborate on addressing the Framework implementation measures, the interdepartmental Assistant Deputy Minister Committee on Science and Technology struck a Subcommittee on Science and Technology Advice to address these requirements. The Subcommittee conducted its work over an 18-month period, from early spring 2001 to fall 2002. Its terms of reference focussed on promoting awareness of the federal Framework across the government, facilitating cooperation on the horizontal elements of the Framework, and sharing best practices and approaches.

The Subcommittee was chaired by the Assistant Deputy Minister of the Environmental Conservation Service of Environment Canada and drew its members from SBDAs as well as central agencies. The Subcommittee organized its efforts around the four following projects, and created working groups to address each project.

Interdepartmental Workshop on Best Practices

The Subcommittee undertook to promote the Framework and share best practices by organizing an interdepartmental workshop. The day-long workshop, hosted by Natural Resources Canada (NRCan) in October 2001, offered an opportunity for departmental representatives to present case studies that demonstrated effective mechanisms for the use of S&T advice for good governance (see box below) and to highlight how these cases align with the Framework principles.

The workshop also provided a learning opportunity to examine the challenges and issues in integrating science and policy, and to share examples of good practices in how S&T is used in public policy.

Interdepartmental Best Practices Workshop

Federal Science and Technology Advice (October 17, 2001)

The following seven case studies were presented:

- Health of Canadians — Food Fortification Policy Review, Health Canada
- Radiocommunications — Communications Research Centre Canada, Industry Canada
- Exotic Forest Pests — Brown Spruce Longhorn Beetle, Natural Resources Canada
- Fisheries Stock Assessment — Evolution of the Science Peer Review and Advisory Process, Fisheries and Oceans Canada
- Climate Change Impacts and Adaptation — Canadian Agriculture, Agriculture and Agri-Food Canada
- Regulation of Organochlorine Mix (AOX) in Pulp Mill Effluent — Environment Canada
- Defence S&T Symposia — Revolution in Military Affairs, Department of National Defence.

Training Course on Science and Technology Advice

The Framework calls for professional development and training programs for government scientists, science advisors, policy analysts and decision makers to address the following areas: requirements of the Framework, means to improve the science/policy interface, and science communication.

Effective science communication and strong working relationships between scientists and policy advisors are critical to achieving the S&T advice principles of the Framework. It is equally important that scientists, policy analysts and decision makers effectively communicate with the public and stakeholders. There are a number of existing government training courses related to S&T management and policy development that address the three key training elements noted above. An example is the Risk Communications and Media Training Course that was developed under the Memorandum of Understanding (MOU) between the Five Natural Resources Departments on Science and Technology for Sustainable Development,[7] and which is now offered through private sector trainers. This course assists the federal science community in preparing itself to better disseminate scientific knowledge to the media and the public at large.

Recognizing a gap in jointly training the science and policy communities on how S&T advice and decision making interact in the policy process, the Subcommittee tasked NRCan and Environment Canada to design and deliver a pilot training course. The two departments engaged Dr. Bruce Doern of Carleton University to develop a model training course and materials entitled "Science and Technology Advice and Policy."

7. The five federal departments are Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada and Natural Resources Canada.

The strength of the course is the opportunity for dialogue between members of the individual science and policy communities arising from four case studies. This practical component of the course helps operationalize the principles for the participants and highlights the different perspectives, work environments, pressures, and biases that exist between the science and policy communities that could cause impediments to communication and integration.

The course material is available to all SBDAs for professional development and training of their science and policy staff.

Science Advice Checklist

To address common accountability issues in the Framework, the Subcommittee tasked a working group led by the Privy Council Office to develop a "science advice checklist" for Cabinet documents.

The checklist consists of a series of questions organized around the six Framework principles. It is intended to provide a valuable means of ensuring that those involved with providing and using S&T advice are aware of their responsibilities with respect to the Framework. This tool is also aimed at informing ministers and senior officials within departments about the S&T advice processes leading to policy formulation and decision making.

Guide and Assessment Worksheet

To assist departments in the evaluation of their S&T advice processes and practices, the Subcommittee developed a comprehensive guide entitled *Implementing the Principles and Guidelines of the Framework for Science and Technology Advice*. The guide provides science and policy managers in federal SBDAs with a worksheet that can be used to assess their adherence to the Framework principles and guidelines. In addition, it includes a glossary of good practices drawn from SBDAs, frequently asked questions, and links to other available tools and documents.

3.3 RELATED ACTIVITIES

Other activities have been undertaken within the Government of Canada to explore how best to strengthen integration between science and policy (see box below). These activities complement the work already undertaken to adopt the Framework and will help departments work towards more focussed science, better informed policy, more effective science policy teams, and an increased confidence in, and understanding of, government decision making.

The CCMD undertook to explore the cultural elements that impede the integration of science and policy for effective decision making. To assist them with this exploration, they struck the Roundtable

Program of Energy Research and Development Integration of Science and Policy

The programs of SBDAs must respond to evolving needs for policy advice on pressing issues such as climate change, clean energy and innovation. NRCan's Program of Energy Research and Development (PERD) operates through 12 federal departments and agencies. Collaboration is PERD's main focus. NRCan regularly evaluates its energy S&T programs and makes funding-allocation decisions based on evaluation results, as well as Government of Canada and NRCan priorities. The department recently realigned energy S&T in the priority areas of hydrogen, biomass-based energy systems and technologies, and energy-efficient industrial systems and technologies. It increased funding for clean coal, carbon dioxide capture and storage, and lightweight materials.

on Science and Public Policy in the fall of 2001, which was made up of 15 members representing the Government of Canada, academia and industry.

In examining the cultural dimensions of the science policy interface, the Roundtable members, in their report entitled *Creating Common Purpose: The Integration of Science and Policy in Canada's Public Service*, suggested that "a new paradigm is required which integrates science and policy functions around key issues, and provides the common purpose of working together to solve problems." See Table 1 for a summary of the Roundtable's findings and suggestions for moving forward.

Integrating science and policy was also one of the four workshop topics explored during the Federal Science and Technology Forum. A summary of the discussion that took place during this workshop can be found in the text box

Table 1: An Overview — Moving from the Present to the Ideal[8]

PRESENT	TRANSITION		IDEAL
Issues at the Interface of Science and Policy	**Cornerstones to Common Purpose and Integration**	**Tools, Strategies and Approaches**	**Benefits**
Conflicting science and public-service value systems and differences in conceptual models between the groups.	Informing about roles and fostering a common purpose for science and policy communities.	Review, discuss and publicize roles for science and policy.	FOR THE SCIENCE COMMUNITY Increased credibility. Increased recognition. Increased trust in policy people. Improved morale. Increased satisfaction.
Communication barriers resulting from differences in language and lack of opportunities for dialogue between science and policy.	Organizing science/policy work teams around the resolution of key issues.	Share information in an iterative process between science and policy.	FOR THE POLICY COMMUNITY Increased trust and understanding of science. More proactive policy decisions. More timely policy responses. More effective, robust solutions.
Misunderstanding surrounding the science and policy processes.	Providing training and development opportunities with exposure to science or policy processes and issues.	Communicate around specific issues in an institutionalized process.	FOR ORGANIZATIONS Better workplace atmosphere. Increased value for money on science investments. Increased relevance of science. Better public policy.
Difficulties in sustaining team and multidisciplinary work resulting from limitations in science capacity.	Recognizing and rewarding science contributions to policy work, and policy contributions to science work.	Reallocate staff capacity to new teams and research areas using incentives.	FOR THE PUBLIC Increased credibility of science. Increased confidence in government decision making. Increased support of federal science.
		Promote development such as job shadowing for science and policy positions.	
		Educate scientists about the policy process and issues, and vice versa.	
		Provide opportunities and incentives for work exchanges between science and policy.	
		Interpret research scientist promotion requirements to recognize contributions to policy development.	
		Communicate expectations to science and policy groups.	

8. CCMD Action–Research Roundtable on Science and Public Policy, *Creating Common Purpose: The Integration of Science and Policy in Canada's Public Service* (Canada: March 2002). **www.ccmd-ccg.gc.ca/research/publications/pdfs/create_e.pdf**

below. (For more details on the Federal Science and Technology Forum, please refer to Chapter 1, page 9.) The issues raised at the Forum have been incorporated into an action plan to be addressed by the federal S&T community.

3.4 WORKING TOWARDS ADOPTION AND NEXT STEPS

In developing the Framework for Science and Technology Advice, the Government of Canada took an important step forward. It is clear that adopting and demonstrating an adherence to the Framework principles, and the continued integration of science and policy, are critical to building and maintaining public confidence in government decision making on science-based issues.

Most SBDAs have begun their efforts to address the Framework by designating departmental science-advice champions, and conducting studies, gap analyses and capacity checks to identify challenges and opportunities to refine existing mechanisms and processes. Based on what they have learned, the departments and agencies are taking appropriate actions to improve and align their science-advisory processes and practices with the Framework.

As a means of sharing best practices, the Assistant Deputy Minister Committee on Science and Technology will undertake future reviews of departments'` implementation of the Framework and its effectiveness. The best practices will be made publicly available through continued reporting on this topic in future reports on federal S&T.

Summary of Delegates' Discussions During the Integrating Science and Policy Workshop at the Federal Science and Technology Forum[9]

- Articulate a national — not departmental — vision for science in Canada. State the purpose of federal science, which is to provide a foundation for evidence and values-based decision making for areas of societal relevance, such as health and environmental sustainability.
- Fund federal S&T adequately so that scientists can have careers. If Canada is serious about establishing a science-based policy, it must commit the necessary resources for a long-term vision, and the time to allow for quality results.
- Provide an environment that supports the vision of integrated science and policy. Values for integrating the science and policy process include respect, objectivity and neutrality — all of which bring credibility and integrity to the process.
- Develop principles and guidelines for policy development. Involve scientists earlier in the policy process.

Additional comments:

- Allow for issue-driven teams in non-crisis times.
- Communication is essential: provide feedback to both scientists and policy makers. Those involved should better understand the policy and purposes of the other side.

9. Report on the Federal Science and Technology Forum, October 1–3, 2002, *Transforming Federal Science and Technology for the Future: Achieving a Vision for Excellence.* **www.sciencetech.gc.ca/S&T%20FORUM/forumreport_e.shtml**

GOVERNMENT OF CANADA INVESTMENTS IN S&T: STATISTICAL INDICATORS

4.1 THE ROLE OF S&T IN THE GOVERNMENT OF CANADA

The role of S&T[10] in the Government of Canada centres on supporting decision making, policy development and regulation; developing and managing standards; supporting public-health, safety, environment and defence needs; and enabling economic and social development.[11] This is accomplished by performing activities within the government and by funding activities in other sectors.

Since the 1980s, the balance between performing the R&D portion of these activities and funding them has shifted. In the 1970s, more than 70 percent of the Government of Canada's R&D budget was spent on in-house activities. However, by 2002, this proportion was expected to drop to 56 percent.[12]

Government of Canada scientists and other professionals are engaged in a wide variety of activities, including conducting research to support their departmental mandates, conducting research into frontier technologies, commercializing their inventions, administering funding programs, participating in international science, and translating scientific findings into policy decisions.

In 2001–02, the Government of Canada employed almost 32 000 personnel who were engaged in S&T activities.[13] Of these, nearly 13 000 employees were classified as scientific and professional, of which more than 6000 were engaged in conducting R&D. The number of scientific and professional personnel conducting R&D reached a high of 6641 in 1993–94. In the late-1990s, the number declined, reaching a low of 5848 in 1998–99. Recently, the numbers have rebounded to earlier levels. The scientific and professional personnel conducting R&D are employed mainly in a wide variety of government laboratories across the country.[14]

While federal intramural expenditures on R&D have increased over the past decade, expenditures by universities and businesses have increased even more rapidly, driven by government policy, federal funding and a rapidly growing economy. As a result, the proportion of R&D in Canada performed by the Government of Canada has declined steadily from more than 30 percent in the early 1970s to less than 11 percent in 2002.

10. There are two main categories of scientific and technological activities:
    - Scientific research and experimental development (R&D) are defined as creative work undertaken on a systematic basis to increase the stock of knowledge, including the knowledge of humans, their culture and society, and the use of this stock of knowledge to devise new applications.
    - Related scientific activities (RSAs) are defined as those activities that complement and extend R&D by contributing to the generation, dissemination and application of scientific and technological knowledge. Listed below are the subgroupings of RSAs divided by field of science:
        — Natural sciences: scientific data collection, information services, special services and studies, education support
        — Social sciences: general purpose data collection, information services, special services and studies, education support.

11. Council of Science and Technology Advisors, *Building Excellence in Science and Technology (BEST): The Federal Roles in Performing Science and Technology* (Ottawa: 1999) [Cat. No. C2-470/2000].

12. Statistics Canada, 1996, *Science Statistics*, Vol. 20, No. 5 [Cat. No 81-001-XIB]; and Statistics Canada, 2002a, *Science Statistics*, Vol. 26, No. 7 [Cat. No 81-001-XIB]. The proportions are based on annualized estimates of gross expenditures on R&D. The figure for 2002 is based on preliminary data.

13. Statistics Canada, 2002b, *Federal Science Activities, 2001–2002*[e] [Cat. No. 88-204-XIE].

14. For a description of these laboratories, consult the Federal Partners for Technology Transfer (**www.fptt-pftt.gc.ca/federal.html**).

4.2 CURRENT SITUATION AND RECENT TRENDS

For 2002, overall national R&D spending intentions[15] declined for the first time since R&D statistics began being collected.[16] Total gross domestic expenditures on R&D (GERD) are expected to decline from $20.8 billion in 2001 to $20.7 billion in 2002. This drop is largely the result of a decrease of about $729 million in business R&D performance. R&D performance in all other sectors increased over the same period.

The GERD to GDP ratio, a common measure of R&D intensity, increased from 1.84 in 2000 to 1.91 in 2001. In 2002, the ratio declined slightly to about 1.85. Despite the recent increases, Canada's GERD to GDP ratio still falls short of the Organisation for Economic Co-operation and Development (OECD) average of 2.24 (see Figure 1).

Government of Canada expenditures on S&T and R&D[17] both increased in real terms[18] between 2001 and 2002. This continues a trend of increasing expenditures evident since 1997. Between 1997 and 2001, federal funding of R&D increased by about 21 percent in real terms (see Figure 2). As a result, the proportion of the federal budget allocated to S&T has increased from 3.6 percent in 1997 to 4.5 percent in 2001.

Despite these recent increases in funding, the Government of Canada's share in both funding and performing R&D in Canada has declined. In 1990, about 16 percent of the R&D performed in Canada was performed by the Government of Canada (see Figure 7). By 2000, this proportion had decreased to about 11 percent. This is the result of higher rates of increase in performance of R&D by business and higher education. This trend is further emphasized by a decrease in the proportion of federal funds allocated to intramural R&D.

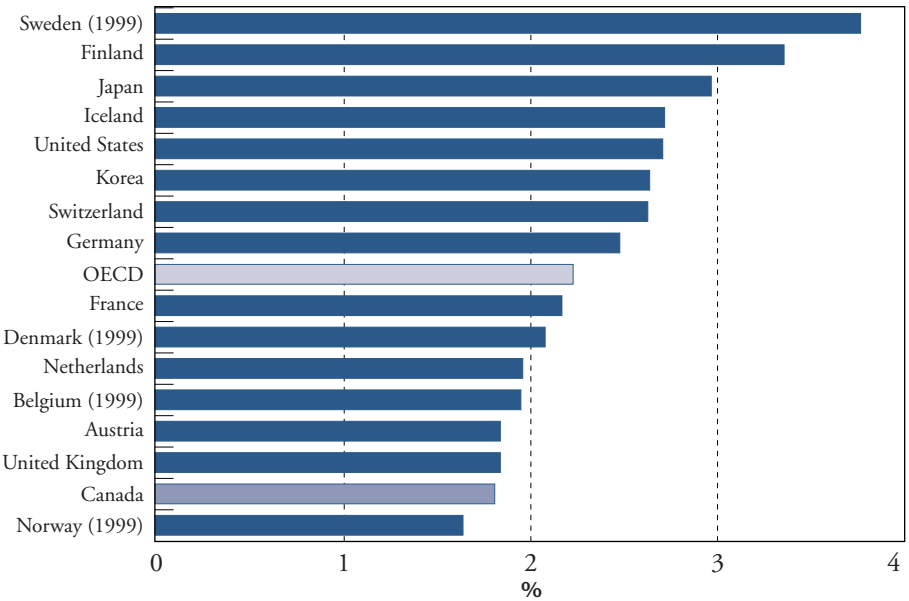
15. Intentions are amounts that the respondents forecast they will spend in the subsequent year.

16. Statistics Canada, 2002a. Note: these figures are in current dollars.

17. The S&T expenditures include R&D plus RSAs, which include education support, technical surveys, information services, special services and studies, and museum services.

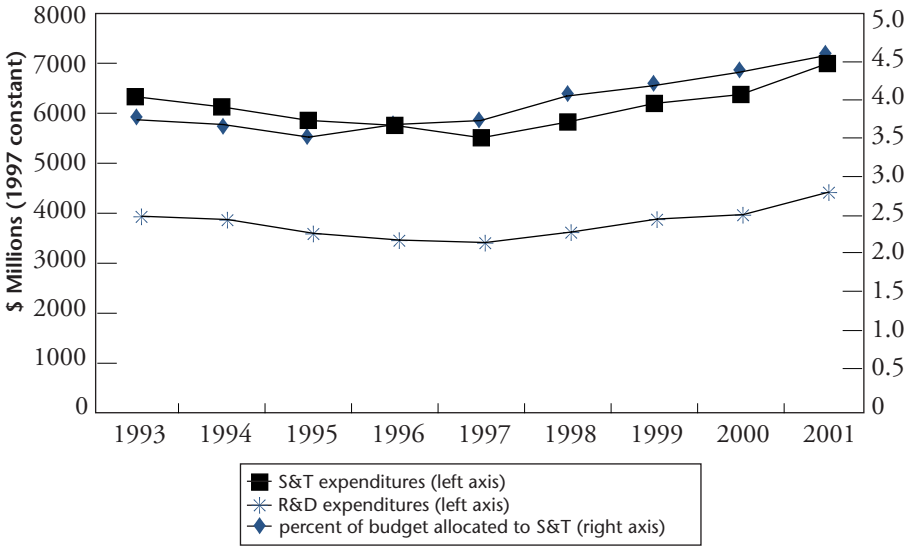
18. "Real" expenditures are actual amounts adjusted for inflation. The base year for these estimates is 1997; therefore, constant dollar values are expressed in terms of 1997 dollars. The adjustment is done by applying the GDP implicit price index.

Figure 1: GERD/GDP, Selected OECD Countries, 2000



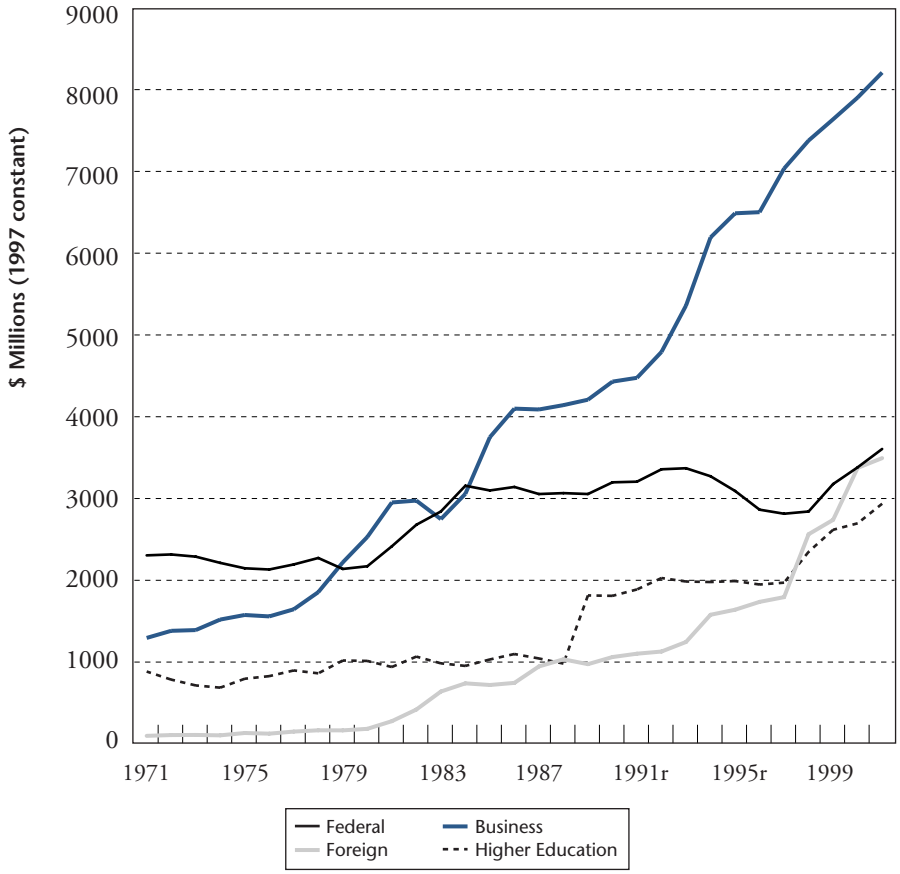
Source: OECD, *Main Science and Technology Indicators* 2002/2, December 2002 (Paris, France) [Cat. No. 94 2002 01 3 p] .

Figure 2: Federal Expenditures on S&T and R&D in Constant 1997 Dollars



Source: Statistics Canada, 2002b.

Figure 3: Funding R&D, 1971 to 2001



Source: Statistics Canada, 2002a.

The trend in federal R&D funding is similar to that of federal R&D performance. In 1990, the Government of Canada funded about 28 percent of the R&D in Canada. However, by the year 2000, this proportion had declined to 18 percent (see Figure 6). Over the same period, the proportion of R&D funded by business increased from 39 percent to 43 percent, and the proportion funded by foreign-sources increased from 9 percent to 18 percent.

Over a longer timeframe, the recent increases in federal funding of R&D are dwarfed by the leaps in funding by businesses, the higher education sector and foreign sources (see Figure 3).

Despite the decreasing national prominence of federally performed R&D in overall expenditures, federal scientists are maintaining their status in many areas. For example, in the area of publications, Government of Canada authors contributed to about 11 percent of all scientific publications in 2000. This proportion has declined slightly from about 13 percent in the early 1990s.[19]

In inventions and commercialization, the Government of Canada received patents for 110 new inventions in 2000–01 (see Table 2) and received more than $16 million in licensing fees from these and previous patents. The licensing fees increased by more than $4 million over 1999.[20]

The BEST report (CSTA, 1999) identifies the aging and obsolescence of equipment and research platforms as a major pressure on federal S&T capacity. Over the past decade, expenditures on construction, acquisition and preparation of land, buildings, machinery and equipment have declined as a proportion of the Government of Canada's R&D expenditures. The peaks shown in Figure 4 for the early-1980s illustrate the influence of the Special Recovery Projects program introduced in the 1983 spring budget. Excluding this period, the proportion of intramural R&D expenditures devoted to capital averaged about 12.5 percent over the late-1980s. Over the past five years, this proportion has averaged less than 8 percent. It is not clear that this statistic necessarily indicates an insufficient level of investment in R&D capital. The rate in the United States, for example, has averaged between 2.5 percent and 3.5 percent over the past decade (National Science Foundation, 2002).

Tables 3a and 3b, at the end of this chapter, provide time series of several key federal S&T indicators.

4.3 LOOKING AHEAD

The government's *Innovation Strategy*, as outlined in *Achieving Excellence*, sets some challenging targets to ensure that Canada becomes one of the most innovative countries in the world. Canada will strive to rank among the top five countries in the world in terms of R&D intensity by 2010. By that date, the Government of Canada has committed to at least double its investments in R&D. In addition, it has signed an agreement with the Association of Universities and Colleges of Canada, whereby universities have committed to doubling the R&D they perform by 2010 and tripling their commercialization performance.

Simple projections of GERD and GDP imply that Finland, Iceland, Sweden, Japan, the United States and Korea could all have GERD/GDP ratios above 3 percent

19. Observatoire des sciences et des technologies, Special tabulations, 2002.

20. Statistics Canada, *Federal Science Expenditures and Personnel, Intellectual Property Management Annex* (Unpublished results).

Table 2: Federal Government Intellectual Property Management, 2000–01

	Invention Reports	Patents Issued	Patents Held	Active Licences	Royalties ($ thousands)
DND	23	11	157	84	528
CFIA	0	0	0	3	816
DFO	2	0	13	28	182
NRCan	22	12	145	85	205
NRC	207	41	655	292	4403
AG	42	21	120	335	4153
HC	20	3	3	0	0
CSA	2	1	20	45	2225
EC	2	2	28	58	673
CRC	28	10	248	397	3100
AECL	4	9	77	14	183
Total	**352**	**110**	**1466**	**1341**	**16 468**

Source: Statistics Canada, 2002, *Federal Science Expenditures and Personnel Survey 2002–03: Intellectual Property Management Annex* (Unpublished results).

by 2010. Furthermore, the European Union[21] recently set a target GERD/GDP ratio for its member countries of 3.0 for the year 2010. Given that the current average for the organization (EU15) is similar to Canada's (about 1.88 in the year 2000), countries other than the six aforementioned may achieve GERD/GDP ratios of more than 3.0 by 2010.

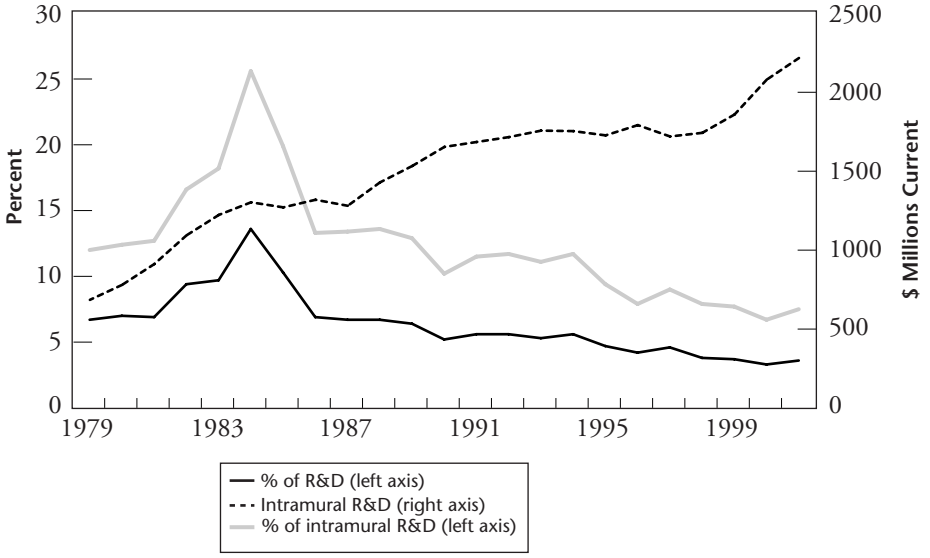
As a result, meeting Canada's target of ranking among the five most R&D-intensive nations by 2010 would require that all sectors of the economy increase their R&D activities significantly in coming years. Increased government R&D spending can contribute to raising Canada's overall R&D intensity, but R&D spending by the business and university sectors will need to increase even more.

As the main funder and performer of R&D in Canada, the private sector will have a particularly important role in this regard. Canada cannot reach its R&D objectives without a sizeable increase in private sector R&D. The university sector will also need to expand rapidly to meet the increasing demand for researchers, scientists and engineers in the Government of Canada and elsewhere. Increased recruitment of foreign talent will also be beneficial.

This would likely mean that the Government of Canada's share of R&D performance would continue to decline over time. (This has been the trend in most OECD countries.) However, a drop in the proportion of Canadian R&D conducted by the government below 11 percent may not signal a declining government capacity; for example, in Japan, the United States and Sweden, the government conducts an even smaller proportion of the country's R&D.

21. European Union, Barcelona European Council: Presidency Conclusions, March 15–16, 2002 (Barcelona, Spain: 2002).

Figure 4: Proportion of Federal R&D Expenditures Allocated to Capital



Source: Statistics Canada, *Federal Science Activities*, various years (Ottawa, Canada) [Cat. No. 88-204].

Nonetheless, the Government of Canada would still need to sustain the recent growth in its R&D investments if Canada is to reach its targets. At 11 percent, the Government of Canada's share of R&D performed in Canada is comparable to the OECD average. As a percent of GDP, government spending on R&D was 0.22 percent for Canada in 1999, slightly below the OECD average of 0.24 percent. By this measure, Canada ranked 13th overall in the OECD. However, federal spending on R&D increased by 50 percent from 1997 to 2002, which is the most recent year for which data are available.

Doubling federal R&D expenditures over a 10-year period would require average annual growth of 7 percent. Between 1997 and 2001, overall federal R&D spending has grown, on average, 8 percent per year, on pace to more than double. The government's support for intramural spending has grown at an annual rate close to 7 percent. The overall growth in federal spending has been led by strong increases in support for extramural R&D — largely in universities and the private sector. Recent growth in this extramural investment has been approximately 10 percent. R&D expenditures by all other sectors grew by 9.5 percent over the same period. Given these trends, even recognizing that it is unlikely that investments in extramural R&D will continue to grow at their current pace throughout this decade, it appears likely that the federal share of R&D performance in Canada will continue to decline. The expected decrease in the federal intramural share will be largely due to the significant increase in industrial R&D that will be required to make our overall R&D target. One scenario for future funding and performing shares, based on the government's R&D targets, is included in Figures 6 and 7, which also look at past shares.

Last year's report on federal S&T *(Investing in Excellence, 1996–2001)* summarized the HR challenges facing federal S&T. The analysis portrayed a work force with:

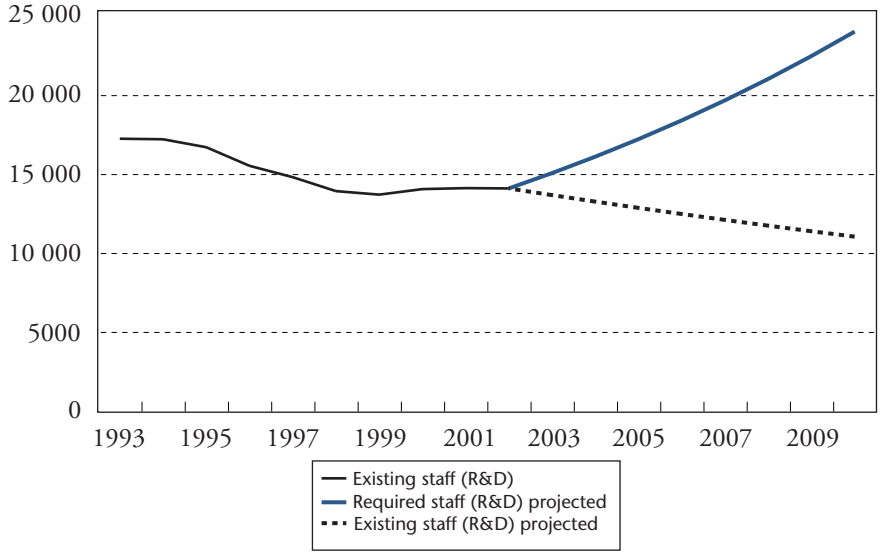
- an increasing average age (more than half of S&T employees were older than 45 years of age in 1997, and only 10 percent were under the age of 35);
- impending retirements (about 15 percent of the S&T work force would be eligible to retire between 1997 and 2002); and
- a tight labour market (only about 18 percent of university students surveyed in 1997 expressed a preference for working in the Government of Canada).

Although some of these conditions may have changed, and some of the expectations may not have been realized, keeping key employees and recruiting new ones are expected to be among the greatest challenges to enhancing the government's S&T capacity.

Figure 5 shows one simple projection. In it, existing staff levels are reduced by 3 percent per year — the expected attrition rate. Personnel requirements are increased by 7 percent per year to parallel the growth in federal R&D performance. This would imply hiring, on average, more than 1000 new R&D personnel per year between 2003 and 2010. Almost half of the federal R&D work force of 2010 would be employees hired since 2003.

Several questions remain concerning the Government of Canada's role in Canadian S&T in 2010. Will it be possible to maintain the growth in performance of the previous five years? Given concerns about the aging of personnel and obsolescence of equipment, what steps will need to be taken to ensure our full participation in the Canadian and international R&D scene of 2010? To quote the CSTA's *BEST* report, "The challenge is not necessarily 'rebuilding' or 'restoring' capacity to historical levels. It is to identify what capacity is needed to allow the government to meet current and future needs, and to enhance its ability to meet these future challenges."

Figure 5: Historical and Projected Federal R&D Personnel



Source: Statistics Canada, 2002b and working group estimates.

Figure 6: Funding R&D in Canada, 1990, 2000 and 2010 (estimated)

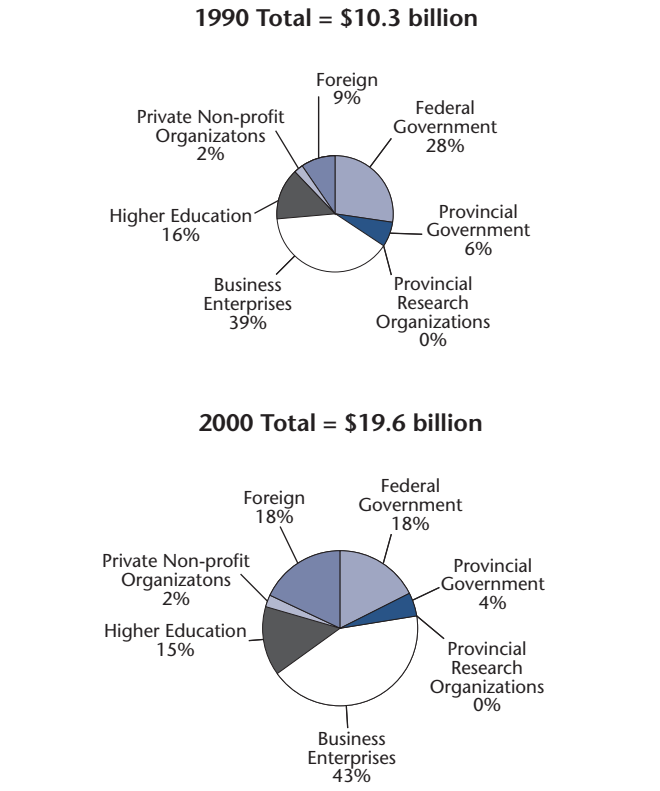
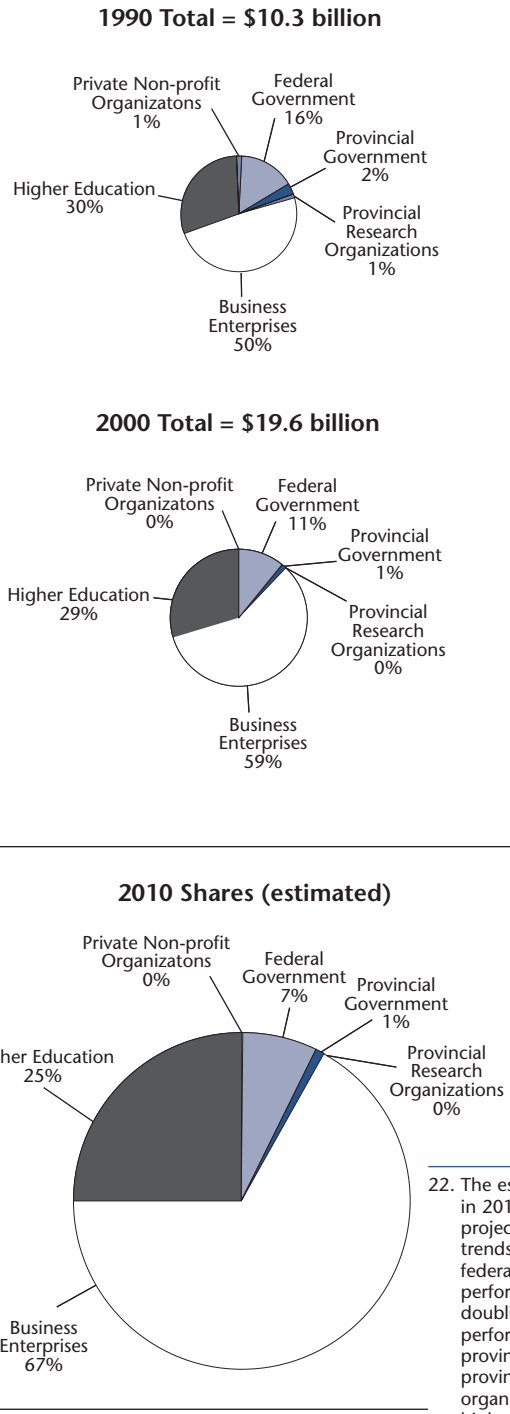


Figure 7: Performing R&D in Canada, 1990, 2000 and 2010 (estimated)



Source: Statistics Canada, 2002a (for 1990 and 2000). 2010 figures are interdepartmental working group estimates.[22]

22. The estimate for shares in 2010 is derived by projecting current trends forward for federal funding and performance, and doubling funding and performance from provincial government, provincial research organizations, the higher-education sector and private non-profit organizations. It also assumes that funding from business enterprises and foreign sources increases by 175 percent.

Table 3a: Federal S&T Indicators (fiscal-year basis)

		FISCAL YEAR ENDING					
	Units	1997	1998	1999	2000	2001	2002
Federal Expenditures							
Budgetary main estimates	$ millions current	149 555	145 457	151 559	156 157	165 234	170 367
S&T	$ millions current	5509	5802	6252	6707	7435	7658
R&D	$ millions current	3379	3578	3890	4150	4680	5071
Percent budgetary main estimates on S&T		3.7	4.0	4.1	4.3	4.5	4.5
Percent budgetary main estimates on R&D		2.3	2.5	2.6	2.7	2.8	3.0
Budgetary main estimates	$ millions 1997	149 555	146 041	150 207	148 438	155 441	—
Annual change	%		–2.35	2.85	–1.18	4.72	—
S&T ($ 1997 constant)	$ millions 1997	5509	5825	6196	6375	6994	—
Annual change	%		5.74	6.37	2.89	9.71	—
R&D ($ 1997 constant)	$ millions 1997	3379	3592	3855	3945	4403	—
Annual change	%		6.31	7.32	2.32	11.60	—
Federal Personnel							
All scientific activities	persons	30 594	29 787	29 485	30 711	31 326	31 681
R&D	persons	14 836	13 952	13 729	14 080	14 141	14 122
Federal Government Outputs							
New patents		—	130	89	—	110	—
Royalties on licences	$ thousands	—	6950	11 994	—	16 467	—
Scientific publications		2985	2845	2688	2891	—	—

Sources:
Statistics Canada, 2002, *Science Statistics*, Vol. 26, No. 7 [Cat. No 81-001-XIB].
Statistics Canada, 2002, *Science Statistics*, Vol. 26, No. 6 [Cat. No 81-001-XIB].
Statistics Canada, 2002, *Federal Science Expenditures and Personnel Survey 2002–03: Intellectual Property Management Annex* (Unpublished results).
Observatoire des sciences et des technologies, Special tabulations, 2002.

Table 3b: Federal S&T Indicators (calendar-year basis)

		CALENDAR YEAR					
Canada	**Units**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
GDP	$ millions current	882 733	914 973	980 524	1 064 995	1 092 246	1 122 712
GDP implicit price index	1997=100	100.0	99.6	100.9	105.2	106.3	—
Population	thousands	29 987	30 248	30 509	30 791	31 111	31 414
GERD	$ millions current	14 639	16 082	17 465	19 585	20 828	20 744
"Real" GERD	$ millions 1997	14 639	16 147	17 309	18 617	19 594	
GERD/GDP	%	1.66	1.76	1.78	1.84	1.91	1.85
"Real" GERD/capita	$ 1997	488.2	533.8	567.3	604.6	629.8	—
GERD funding sector							
Federal government	%	19.2	17.6	18.4	18.2	18.4	19.1
Provincial governments	%	4.5	4.0	4.4	4.5	4.5	4.9
Business enterprise	%	48.1	45.7	44.3	42.5	41.9	40.0
Higher education	%	13.5	14.5	15.2	14.5	15.0	16.5
Private non-profit	%	2.5	2.3	2.2	2.3	2.3	2.6
Foreign	%	12.3	15.9	15.9	18.1	17.8	16.9
GERD performing sector							
Federal government	%	11.7	10.8	10.6	10.6	10.6	10.7
Provincial governments	%	1.5	1.3	1.3	1.3	1.2	1.3
Business enterprise	%	59.7	60.2	58.6	58.5	57.5	54.2
Higher education	%	26.5	27.2	29.1	29.3	30.3	33.5
Private non-profit	%	0.6	0.5	0.4	0.3	0.3	0.3
Federal intramural spending as a % of federal funding	%	61.12	61.59	57.82	58.48	57.84	56.08
"Real" federal contribution to GERD	$ millions 1997	1720	1750	1842	1977	2086	—

Sources:
Statistics Canada, 2002, *Science Statistics*, Vol. 26, No. 7 [Cat. No 81-001-XIB].
Statistics Canada, 2002, *Science Statistics*, Vol. 26, No. 6 [Cat. No 81-001-XIB].
Statistics Canada, 2002, *Federal Science Expenditures and Personnel Survey 2002-03: Intellectual Property Management Annex* (Unpublished results).
Observatoire des sciences et des technologies, Special tabulations, 2002.

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 that it carries out to deliver on its mandate. The activities described below cover the year 2002. Where appropriate, SBDAs will report on the steps they have taken to implement the Framework for Science and Technology Advice for policy and regulation development and for decision making.

AGRICULTURE AND AGRI-FOOD CANADA

Science, Research and Technology Development

Work in science, research and technology development continues to be fundamental to the department's commitment to Canadians and its vision for the agriculture and agri-food sector.

The marketplace continues to see significant shifts. Consumers around the globe are more knowledgeable and more discerning than ever before. They want assurances that new products created by advanced and innovative technologies are safe. They are concerned about the food they eat and the impact that agriculture has on 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 to address consumers' needs and expectations.

Agriculture and Agri-Food Canada (AAFC), along with its provincial and territorial counterparts and the agriculture and agri-food industry, is putting in place a comprehensive agricultural policy that will increase the profitability of the entire agri-food sector. The Agricultural Policy Framework (APF) (**www.agr.gc.ca/cb/apf**) will provide producers with the choices and tools to strengthen their businesses. It will help them meet the demands of consumers in Canada and around the world, while responding to increased global competition and keeping up with rapid technological change. By linking the three elements noted below together in a comprehensive approach, the APF will ensure that the Canadian agriculture and agri-food sector has a solid platform from which to maximize opportunities at the dawn of the new century.

Food Safety and Quality

Canada enjoys a global reputation for consistently delivering safe, high-quality food. Many players are already moving to adopt systems that offer documented evidence of safety and quality. The APF will help industry develop these systems throughout the entire food chain and expand food safety and quality monitoring at the production level.

Environment

Environmental stewardship is key to both the industry's long-term sustainability and profitability. The industry is well aware of this and is already taking action to manage known environmental risks.

The APF sets out areas where governments can provide help, including better information and research on the links between agriculture and the environment, the development of best management practices, and stepped-up action on environmental priorities on farms through agri-environmental scans and environmental farm plans.

Renewal and Innovation

One of the goals of the APF is to make the sector the world leader in innovation. The APF emphasizes the coordination of research and innovation efforts across governments, the sector and private research institutions to achieve maximum return on investments in the key areas of food safety, the environment, and innovative production.

The Speech from the Throne (SFT) specifically indicates that implementing the APF is a key priority for this government.

The work to develop and implement the APF is aimed at providing those in the agriculture and agri-food industry with the tools to improve their profitability and their opportunities to compete in the world. Implementing the Framework will have benefits for consumers, the industry and Canada's economy.

Science will continue to be strengthened by integrating efforts across departments and disciplines, and by focussing on the priorities of Canadians. With better integration of our science efforts, we'll be encouraging the public and private funding of agricultural research, and assisting in the early application of research results.

Aligned with the government's commitment to innovation, efforts under the APF are intended to:

- create the climate and infrastructure to foster agricultural innovation that will open new markets and new market opportunities for the industry,
- bring benefits to consumers, and
- generate dividends for the Canadian economy.

The SFT identified $5.2 billion for the Framework, with $243 million for science in general and $166 million going to science in AAFC in particular. This commitment reflects a revitalized department and a multistakeholder agriculture agri-food sector.

The role of science remains central to achieving a balance between economic, social and environmental considerations by providing knowledge, information and advice to both internal and external clients, developing and transferring technology, and implementing policies and programs.

Recognizing the need to strengthen the link between science and policy and to integrate science with strategies for policy development, rural issues and domestic and international trade, AAFC science has been organized into national programs. These programs are closely aligned with the APF elements and are embedded in the new AAFC horizontal team governance structure, which includes membership from across the department, from coast to coast. The programs are the following:

- Environmental Health — research to develop knowledge and technologies that will minimize the impact of agricultural production on natural resources;
- Sustainable Production Systems — research to develop systems of crops and livestock production that are economically and environmentally sustainable, and improve the competitiveness of Canadian agri-food products in domestic and international markets;
- Bioproducts and Bioprocesses — research to discover and develop value-added bio-based products and processes; and
- Food Safety and Quality — research to provide the knowledge and technology needed to enhance the ability of the Canadian food industry and the government to keep the food system safe, and to produce quality food products for current and future consumers.

Science priorities are influenced by the important process of seeking external advice. One such source of advice is the Canadian Agri-food Research Council, a multistakeholder group that operates independent of government. It is composed of representatives from the universities, industry associations, producer organizations, federal and provincial governments, and scientific societies (**www.carc-crac.ca**). Annually, the Priority Setting Committee identifies major priority areas.

In the context of AAFC's realignment and the recent recommendations of the Council of Science and Technology Advisors, AAFC requires a broader-based science advisory body (SAB) to provide external advice to the department on public research priorities. The composition of the new SAB aims to reflect academia, environmental, consumer and industry perspectives.

Peer review is currently evolving to include expert external advice in the review of proposals, and ongoing and completed research activities. This change will ensure scientific excellence and allow the department to demonstrate the

optimal use of resources to develop the results that reach the marketplace.

Science and research activities at AAFC bring a long and successful history of collaboration with external partners to the development and implementation of the APF.

AAFC has recently become an active member in the BioControl Network (**www.biocontrol.ca**). The research network is aimed at reducing the use of pesticides by replacing them with the natural enemies of insect pests and disease pathogens.

Canadian scientists have developed a first-ever fusarium-tolerant pastry wheat. With fusarium head blight an ongoing concern in eastern Canada, the new variety, developed with Hyland Seeds, is welcomed by growers (**www.agr.gc.ca/cb/news/2002/n21119ae.html**).

Since SSD Slurry Manure Applicators commercially launched in 2001, they have put more than a billion litres of livestock manure on agricultural land, conserving many tons of ammonia while controlling offensive odours. The applicator allows producers to effectively replace fertilizer with manure as the prime nutrient source.

The original system was developed by a team of AAFC researchers in Agassiz, British Columbia, with industry manufacturing and marketing from Holland Equipment Ltd., and was the winner of an American Society of Agricultural Engineers Top 50 award in 2001.

Through the APF, science will continue to support food safety and quality, environmental stewardship and the renewal and revitalization of Canadian agriculture. With this focus in mind, AAFC will continue to seek collaboration with partners inside and outside of the federal science community to improve the value of science to Canada.

Contact Information

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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, adoption and adaptation of new technologies and processes, 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" further in this section for details).

Foremost among these initiatives 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 also 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 public and private research facilities, leading to the launch of new ideas, products, processes, and services. The AIF is overseen by an advisory board composed of knowledgeable academics, business leaders and experienced R&D/technology professionals, who make recommendations to ACOA's minister on specific project proposals.

The fund was designed as a catalyst to bring 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.

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. On July 2, the Honourable Gerry Byrne, Minister of State for ACOA, announced that 47 projects had been selected, totalling approximately $155 million in funding. The selected projects represent a mix of private sector, university and community college initiatives located throughout the region. They relate to a range of new and emerging sectors, such as information technology, biotechnology, medical, ocean and environmental technologies, as well as manufacturing, oil and gas, and mining. The projects funded have an overall value of nearly $400 million. For every dollar of AIF funding, the project proponents have leveraged two-and-a-half times that amount in additional funding from a variety of private and public sector sources. AIF's second request for project proposals for funding was launched on August 23, 2002, and closed on November 27, 2002.

In October 2002, the Agency launched the Innovation Skills Development Initiative (ISDI). ISDI is one of three key components of the Agency's $59.6-million Entrepreneurship and Business Skills Development Partnership. The purpose of the ISDI is to help SMEs incorporate enhanced innovation management and technical skills into their firms, to make them more productive and globally competitive.

The key objectives of the ISDI are to:

- enhance Atlantic SMEs' innovation and technology management capabilities;
- increase the Atlantic region's pool of experienced technology managers and technical expertise; and
- retain greater numbers of qualified S&T graduates within Atlantic SMEs.

The following projects are some examples of where ACOA has continued, in the past year, to help strengthen the innovation and S&T capacity within the region:

- As part of a strategic initiative to enhance the innovation environment in New Brunswick SMEs, ACOA arranged two workshops entitled "Winning at New Products" attended by 65 companies. The sessions are based on the Stage Gate™ new product development process that helps drive projects from idea to launch.
- With the support of ACOA and the Canada Foundation for Innovation, the Nova Scotia Agricultural College is building its research capacity in three key areas. It has expanded its capability for water-quality research and monitoring water drainage and runoff flow, strengthened its capacity to develop better crop production methods and to evaluate long-term effects under commercial conditions, and enhanced its capability to undertake molecular genetics activities.
- The Atlantic Technology Centre (ATC) was officially opened in September 2002 in Charlottetown, Prince Edward Island. The 12 000-square-metre centre features key infrastructure for P.E.I.'s technology and media production sectors, including state-of-the-art office space, training labs, and specialized research labs, as well as a world-class media production environment. The launch coincided with Softworld 2002, an information technology forum held in Charlottetown, attended by hundreds of senior information technology executives.
- ACOA provided support for the continuing operation of the Genesis Centre at Memorial University in St. John's, Newfoundland and Labrador. The Centre, operated by GENESIS Group Inc., is an incubator for high-growth, technology-based businesses. The Centre has accepted and worked with 22 clients since its opening in 1997, and hopes to accept six new companies in the next two years.

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 and critical mass; and
- 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 continue to 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.

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CANADA ECONOMIC DEVELOPMENT FOR QUEBEC REGIONS

Since the fall of 2001, Canada Economic Development for Quebec Regions has focussed on several facets of innovation. In particular, the agency is investing to help foster:

- the startup and pre-startup of technological enterprises;
- the adoption of advanced business practices;
- access by enterprises to specialized technology-transfer services; and
- the development and marketing of new products by enterprises.

The agency also invests to contribute to the increase of R&D activities in research centres and institutes, leading to the marketing and improvement of products and processes.

In 2001, following the termination of the Canada Jobs Fund, the agency was awarded an additional budget of $177 million over four years. The agency is using that budget in part to reinforce its activities associated with innovation, productivity and the knowledge economy in all Quebec regions. In keeping with its mandate, it places special emphasis on regions where growth is slow and employment inadequate. In its work with enterprises, Canada Economic Development for Quebec Regions places a priority on maximizing the leverage effect of its contributions. More specifically, it seeks to ensure that each dollar invested generates the highest possible direct investment from SMEs.

To reinforce SMEs' competitive position, the agency also places a priority on helping them to modernize their business practices and develop their capability to innovate. Attention is also paid to helping them strengthen their marketing capacities, particularly to help them penetrate foreign markets. Through the agency's financial support, enterprises are assisted at every step as they more toward adopting new business practices. The agency also becomes directly involved with businesses to provide expertise — to assist them in carrying out diagnostic exercises, or in developing and carrying out implementation plans.

Canada Economic Development for Quebec Regions has also provided financial assistance to contribute to the development and improvement of knowledge infrastructure. Often studies concerning the feasibility or establishment of research centres must be carried out before new infrastructure can be developed or existing infrastructure upgraded. The agency, therefore, has contributed to several feasibility or establishment studies, notably in the areas of technological innovation, computing, aerospace, aluminum processing, plant biology and agri-food. The results indicate that some of these initiatives, such as the construction or fitting-out of laboratories or premises and the acquisition of specialized equipment to develop or upgrade knowledge infrastructure, could emerge as capital projects over the next few years.

Through financial support for the preparation of grant applications, the agency contributes to promoting knowledge institutions vis-à-vis national initiatives to support innovation. An application backed by national initiatives can emerge as a project with strategic impact for the development of a region's economy. Finally, the development, dissemination, and sharing of knowledge are other ways that the agency participates in the development and reinforcement of knowledge-based competitive advantages. Its contributions take various forms. For example, projects aimed at the organization of events leading to the dissemination and sharing of the results of different research were successfully implemented. Other projects target funding for the startup or operation of organizations working to develop the knowledge economy. Finally, some projects focus more on fostering the development or technological demonstration of new products.

The development of a culture of innovation among businesses is central to a modern vision for regional economic development. To innovate, businesses must not only acquire new skills and adopt new technologies, but must also be able to depend on a system of knowledge infrastructure and networks that foster the development, transfer and transformation of knowledge into commercial success. For this reason, Canada Economic Development for Quebec Regions plans to increase its involvement in innovation and productivity, and to include trials and experimentation involving new products and procedures for regions that depend mainly on natural resources.

Contact Information

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Web site: **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 Government of Canada food, animal, and plant health inspection programs. As a science-based regulator, the CFIA is committed to enhancing the safety of food sold or imported into Canada, contributing to the health of animals and protecting the national plant resource base. Decision making is science-based, and the CFIA's credibility in Canada and abroad rests on its ability to provide expert scientific services.

Implementing the Framework for Science and Technology Advice

The CFIA has been an active participant in the development of strategies for the implementation of the Framework for Science and Technology Advice. Senior management, the Science Committee and area management councils are committed to the Framework. Strong support was received from research scientists with the CFIA, Health Canada and the AAFC during an annual interdepartmental food safety and nutrition forum to identify research priorities. To secure adherence to the Framework, linkages to the principles and guidelines have been incorporated into the CFIA's Framework of Policy Making. Case studies are under development for inclusion in an e-learning tool to be available to all CFIA employees. Also, a Guide for Science and Policy Managers is being evaluated within the CFIA, and an action plan for the implementation and use of a self-assessment worksheet is being developed.

Advancing Other Federal S&T Initiatives

The CFIA is actively involved in developing the Vision for Canadian Government Leadership in Science and Technology, by participating in an interdepartmental working group that is developing action plans from recommendations proposed at the October 2002 Science and Technology Forum. The CFIA is also contributing to the federal Science and Technology Foresight Pilot Project at all levels, including the initial working group, project team, scoping workshops and expert panels. Discussion in many of the expert panels included numerous issues related to food safety and animal and plant health.

Food Safety

At the federal level, Health Canada and the CFIA play unique and complementary roles in the safety of Canada's food. By partnering with provincial and territorial governments, expertise is shared and activities coordinated to facilitate compliance with federal and provincial requirements and the delivery of emergency response services such as food recall. The CFIA works with industry and consumer associations to identify and address emerging concerns related to food safety and labelling. The CFIA has developed and is working with provinces toward the adoption of a standard for assessing food hygiene in the Canadian food industry. As a result of a joint review with the import sector, the CFIA is developing a protocol for allergen control.

Protection of the Animal Resource Base

Animal diseases can threaten the health of the national herd, the economic stability of the agricultural sector and, in some cases, the health of Canadians. The international marketability of Canadian livestock and animal products and by-products is enhanced by Canada's reputation for being free from certain serious animal diseases. In addition to standard prevention measures at the border and surveillance efforts nationwide, a collaborative response with provinces and industry would limit the breadth and duration of an incursion. Two recent initiatives from a livestock-control perspective are cattle identification and zoning. The Canadian Cattle Identification Program, a CFIA-approved ear tag program initiated by industry, permits rapid tracing when a reportable animal disease, chemical residue, or other food safety issue has been identified. Information linking the tag to the producer is maintained

until completion of the inspection process. Similar programs are being explored with the sheep and pork industries. Industry and government are pursuing ideas outlined in a March 2002 document on zoning.

The CFIA has conducted several major risk assessments, including country assessments, on bovine spongiform encephalopathy and foot and mouth disease. In addition, a comprehensive review and assessment of biocontainment and the safe disposal of prion-contaminated material has been carried out to further advance Canada's emergency response capacity.

Response to Threats from Plant Pests and Pathogens

The health of the plant resource base is crucial to Canada's economic well-being. Through import-permit requirements for regulated products, inspections at the border and surveillance activities, the CFIA guards against the entry and spread of pests from foreign countries. As well, the CFIA works within Canada to control and eradicate pests. New molecular technologies are being used to enhance rapid identification of nematode parasites, viruses and fungal pathogens. For example, research is under way to develop molecular tests for the causal agents of potato wart disease, potato mop top virus and dwarf bunt. Surveys and research are focussed on the control and eradication of quarantine pests such as Plum Pox Virus, the causal agent of a devastating viral disease of stone fruits. The CFIA supports research on regulatory efforts in plant biotechnology — for example, gene flow for crops such as canola and a generic study on pollen movement. Research is under way to assist in the development of management plans for the development of pest-resistant cultivars of plants derived from biotechnology.

Working Globally in an International Regulatory Framework

International standards provide a framework to support trade of food, animals and plants. The continued development of a harmonized regulatory framework, which is both science- and rules-based, benefits Canadians by providing them with safe products from international and domestic markets. The CFIA is a leader in responding to international trends and strives to influence international standard setting organizations. To this end, the CFIA, along with Health Canada and other Government of Canada departments, participates in international organizations such as the International Plant Protection Convention, the Office International des Épizooties, and the Codex Alimentarius Commission.

Broadening the CFIA's Science Knowledge Base

The CFIA uses science fora as a collaborative means to enhance employee awareness of potential national and international developments in S&T. The fora also provide an opportunity for employees to contribute to the development of strategic programs and policies. In June 2002, the CFIA hosted a Traceability Science Forum to explore the potential of traceability as an emerging risk management tool. In December 2002, the CFIA partnered with the Office of the Chief Scientist at Health Canada in co-hosting a Risk Assessment Science Forum. The objective was to stimulate discussion relative to the science underpinning regulatory activities and to ensure that science is sound. Participants included the CFIA, Health Canada, other federal departments, and provinces. Feedback was positive and there is much interest to collaborate in hosting future science fora.

The CFIA has revised its research granting program, the Research Partnership Strategy (formerly, the Matching Investment Initiative), to broaden the terms of reference to include partnerships and collaborations with universities, foundations, and provincial and federal partners. The initiative will broaden the CFIA's knowledge base gained from regulatory research to address food safety, animal-health or plant-health concerns. A sabbatical renewal program and a university study program for scientists to pursue postgraduate studies have been initiated to strengthen human resources and address related issues.

Promoting Collaboration and Partnerships on the Domestic Front

The CFIA partners with other Government of Canada departments on areas of mutual or national interest, such as the Chemical, Biological, Radiological and Nuclear Research and Technology Initiative (CRTI). The objective of the CRTI is to enhance preparedness and readiness to deal with a terrorist attack. It has several important thrusts: a risk assessment of the potential for terrorist attack, funding for immediate technology acquisition to improve preparedness and build capacity, and funding for technology acceleration and development. The CFIA participates in laboratory "clusters" that

collaborate to enhance cooperation between laboratories and first responders. The CFIA partners with Health Canada in co-chairing the biological cluster.

In co-chairing fora such as the Federal/Provincial/Territorial Agri-Food Inspection Committee and the Canadian Food Inspection System Implementation Group, the CFIA provides leadership to ensure a coordinated approach to advance food safety and animal and plant health in Canada. Science-based recommendations or resolutions are developed for federal, provincial and territorial ministers for:

- the resolution of technical barriers to interprovincial or territorial trade in agricultural products;
- the development of model regulations and codes in support of an integrated food inspection system; and
- the resolution of various technical issues related to agri-food products.

Examples of recent accomplishments include the development of the On-Farm Food Safety Recognition Program and the development of a framework for determining the equivalence of provincial/territorial milk-production legislation and delivery systems to the National Dairy Regulations and Code. Emerging priorities are linked to the food safety goals of the Agricultural Policy Framework — for example, a coordinated federal/provincial/territorial approach to traceability.

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CANADIAN INSTITUTES OF HEALTH RESEARCH

In June 2002, the Canadian Institutes of Health Research (CIHR) celebrated its second anniversary. 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." As Canada's premier health research organization, CIHR supports research and training in four pillars of health research: biomedical science; clinical science; health services and systems research; and social, cultural and environmental determinants of population health. In addition, CIHR has a mandate not only to create new knowledge but also to translate that knowledge into improved health for Canadians. Knowledge translation means turning research into results to improve health products and services, create more effective health policy and practice, and strengthen the health care system.

To bring about new knowledge, stimulate economic growth and ensure health benefits for all Canadians, CIHR has developed Canada's first national agenda for health research focussing on the following four strategic directions:

- building international leadership through national excellence in health research;
- integrating the various disciplines of the health research spectrum;
- improving the health status of vulnerable populations; and
- strengthening health research and the health system in the genomics era.

CIHR's 13 virtual Institutes are instrumental players in ensuring these strategic directions are fulfilled. In consultation with advisory boards and stakeholders, the Institutes have developed nine research priorities that embody the principles of the strategic directions. They include brain and spinal cord repair, environmental and genetic interactions in circulatory and respiratory diseases, obesity and healthy body weight, proteomics and bioinformatics, osteoarthritis, the biological and social determinants of healthy aging, investments in population-based data bases, health human resources, health care evaluation and technology assessment, and analyzing and reducing health disparities.

CIHR cannot fulfill its mandate alone and has entered into partnerships with other Canadian and international health research organizations, including the voluntary sector, provincial organizations, federal departments and agencies, and biotechnology and pharmaceutical companies. Since research must engage the users and practitioners of health care, CIHR has also engaged communities and stakeholders in health research on issues relating to safe food and water, homelessness, global health, environmental health, and rural and northern health, to name just a few.

Major S&T Achievements

During the fiscal year 2001–02, CIHR supported 4147 operating grants, clinical trials, equipment and maintenance grants, and other grants and awards at a total cost of $353 698 000. CIHR also provided 646 salary-support grants and awards totalling $35 073 000, and 1850 research training grants and awards totalling $39 533 000. CIHR was able to increase its number of grants over last year by 22 percent and the average grant value by 11 percent. Success rates in CIHR competitions are now comparable to those of the U.S. National Institutes of Health (around 30 percent).

Other initiatives in support of research (conference support, travel and exchange, Institute support grants) totalled $20 226 000 for 136 projects and initiatives. CIHR also supported the Networks of Centres of Excellence ($24 810 000) and 167 Canada Research Chairs ($21 200 000).

The Government of Canada's sustained investment in health research and training, and CIHR's dedication to excellence in these areas are already yielding nationally and internationally recognized results.

Diabetes — If research in Edmonton by Drs. James Shapiro and Ray Rajotte and their team hold up, Canada will once again have made a major contribution to juvenile diabetes research and treatment. The "Edmonton Protocol" is supported by a unique partnership of CIHR, the Alberta Heritage Foundation for Medical Research, the Juvenile Diabetes Research Foundation, and Wyeth–Ayerst. This unique study, involving the transplantation of islet cells into the liver to help patients stay insulin-free, illustrates the potential of health research to yield enormous economic and social returns on relatively small investments. Diabetes is the seventh leading cause of death by disease, affecting more than two million Canadians and costing the health care system $9 billion annually. Indirect costs, including time off work by parents and the social costs of living with a life-long chronic disease, are also substantial.

Neurology — Thanks to support from CIHR, Drs. Molly Shoichet and Charles Tator from the University of Toronto have grown spinal cords in porous tubular "bridges" implanted in rats. While it is too early to declare a solution to spinal cord injuries, the results of this research show that this bridge, which allows tissue to grow, may be a cause for hope.

Extending Life Through Commercialization — Thanks to a CIHR Proof of Principle (POP) grant, Dr. Yves Raymond of the Université de Montréal is determining the potential of a unique technology to improve the life expectancy of thrombosis (stroke) victims and reduce health care costs. POP program grants provide support for research projects aimed at establishing proof of a discovery's principle, thereby improving the likelihood of its commercialization. The POP program is offered in conjunction with two other notable programs: the CIHR SME Program and the CIHR/Rx&D program. The former is jointly funded by Canadian biotechnology companies to strengthen Canada's technology-transfer capacity by supporting research commercialization in startup companies, university spin-offs and SMEs. The latter is a partnership between CIHR and Canada's research-based pharmaceutical companies that facilitates collaborative partnerships between university, academia and government with the aim of developing new drugs for the treatment of disease.

Protection Against E. coli — Tragedy struck Walkerton, Ontario, after E. coli from cow fecal matter contaminated the town's drinking water. As a result, government inspectors adopted a policy of zero tolerance toward beef that carries a particular E. coli strain. The cost to meat producers has been staggering — as much as $5 billion annually. CIHR Distinguished Investigator Dr. Brett Finlay, a professor at the University of British Columbia, has developed a vaccine to protect cows against E. coli. Dr. Finlay's vaccine has been effective in a small number of cows and is now being tested in more than 70 000 of these animals. If successful, the vaccine will help reduce both the dramatic economic and health costs associated with E. coli contamination.

Cost Savings to the Health Care System — Of the more than 10 000 pacemakers implanted annually in Canada, more than 40 percent are a dual-chamber type, which costs $2500 more than a single-chamber device. Research led by Dr. Stuart Connolly of McMaster University shows that the more expensive version has few advantages over the single chamber. The savings promise to be substantial: up to $10 million per year to the Canadian health care system. CIHR's continued support for Dr. Connolly's research will enable Canada's health care system and patients to profit from this new knowledge.

Training and Career Development — Launched last year by CIHR and its partners, CIHR's Strategic Training Initiative in Health Research (STIHR) is the most ambitious and innovative

training program of its type in North America. The STIHR initiative will build a culture of creativity and innovation while promoting an interdisciplinary model among the next generation of health researchers. STIHR develops a broad range of capabilities amongst trainees, ensuring that the next generation of health researchers is comfortable working collaboratively across broad research areas. Following a rigorous peer review process, CIHR and its partners have funded 51 training centres — a commitment of nearly $100 million over six years.

CIHR's Establishment Grants contribute to brain-gain in Canada by helping host institutions develop competitive recruitment packages that attract established, internationally recognized health researchers. Dr. Prabhat Jha was recently recruited to Toronto's St. Michael's Hospital from the World Health Organization in Switzerland, to research the spread of HIV- and tobacco-related illnesses. Dr. Jeremy Grimshaw was recruited to the Ottawa Health Research Institute from the University of Aberdeen in the United Kingdom Dr. Grimshaw's research will focus on ways to improve the uptake of research findings by health professionals.

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CANADIAN MUSEUM OF NATURE

The Canadian Museum of Nature (CMN) is Canada's national natural history museum, with operations based in two major facilities. The Natural Heritage Building in Gatineau, Quebec, houses a state-of-the-art collections-holding facility, research laboratories, a new centre for digital imaging, and offices for most of its 165 staff. The historic Victoria Memorial Museum Building (VMMB), located in downtown Ottawa, houses the CMN's public exhibitions and educational programming. Together, these facilities are focal points for collections development, primary research, exhibition creation and educational activities. All contribute to programs about the natural history of Canada and associated issues of relevance to Canadians.

The Museum has prepared a new five-year strategy to focus attention on environmental change affecting the natural world. It works with the science community, decision makers and the general public to understand the critical issues affecting environmental change, the role that humans play in accelerating this change, and how these changes affect the distribution of plants and animals and their habitats. This work will be most visible in programming activities to be delivered in the newly renovated VMMB, slated for renovations from 2003 to 2008.

The new vision of the CMN stresses partnerships and joint efforts to achieve new projects, such as *The Geee! In Genome*, a new exhibition on genomics. During the past year, the CMN has produced this exhibition along with key partners, Genome Canada and CIHR. The exhibition will open at the CMN in spring 2003, then travel to other cities across the country. *The Geee! In Genome* will be supplemented by a dynamic and interactive Web site, as well as a series of forums held across Canada to stimulate awareness on the ethical issues involved in genomics research.

The CMN continues to be a Canadian centre of excellence for systematics research and natural history collection, conservation and management. Our collection and research staff, numbering 50, curates a collection of 10 million specimens, produces an average of 50 peer-reviewed scientific publications and books annually, entertains hundreds of research and V.I.P. visits, participates fully in the academic community through eight adjunct professorships, and describes 20 to 30 new species of plants, animals and minerals each year.

The CMN's natural history collections are part of a public trust, developed to preserve our natural heritage and to document the historical record for both scientific advancement and educational value. Part of the CMN's future focus will be to develop a national collections development strategy, in partnership with a coalition of natural history museums in Canada. The CMN will broaden access to the natural history record using the Internet, collection images and distributed data bases.

The CMN continues to work with the Canadian Heritage Information Network, a special operating agency of the Department of Canadian Heritage, and the Biodiversity Knowledge and Innovation Network, which includes numerous natural sciences partners. In both cases, the CMN is using centralized and distributed data bases to mediate access to collection and specimen records. Both the general public and scientific communities are potential consumers and

contributors of this data. Examples include the compilation of data from a community-based science program such as the Rideau River Biodiversity Project, or the conversion of flora and fauna records from catalogue card to digitized data.

Another example of CMN's commitment to sharing information and knowledge is its agreement with Arius3D Inc. of Mississauga, to establish a centre for 3-D imaging within the NHB. With the support of Canadian Heritage, the CMN is installing Arius' innovative cameras and software to produce true-to-life, full-colour, 3-D images of specimens from its natural history collections. The images (or models) will be used for education, research and collections management.

The CMN shares its scientific expertise on collections management and conservation issues with other national and international institutions. Museum staff have presented numerous workshops and have consultated on risk analysis for the conservation of collections. Additionally, the CMN is examining the implications to collections management of storing and managing tissue samples and DNA sequences in addition to whole specimens.

The CMN's collection-care expertise was further recognized in a recent service agreement with the government of Nunavut. The Museum agreed to curate all fossil material collected under scientific permit, until a facility exists in the new territory.

The Museum's research expertise is integral to a number of Government of Canada, professional and academic initiatives, including the Committee for the Status of Endangered Wildlife in Canada (COSEWIC), the Canadian Arctic Shelf Exchange Study, the Pan Arctic Flora Project, and the New Mineral Names Committee of the International Mineralogical Association. The CMN is a founding member of COSEWIC, and leader on two of COSEWIC's expert subcommittees — invertebrates and freshwater fishes.

The Museum houses and totally supports the Biological Survey of Canada (Terrestrial Arthropods), and has done so for more than 20 years (**www.biology.ualberta.ca/bsc/bschome.htm**). 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.

Through the Canadian Centre for Biodiversity, the CMN houses and provides support for the Secretariat of the Canadian Committee for the International Union for the Conservation of Nature. The CMN also hosts the Medicinal Plant Species Specialist Group of the Union's Species Survival Commission.

The Museum is exploring new ways to make natural history more understandable to the public. With our partners at CineMuse Inc., the Museum is promoting high-definition cinema as an interpretive tool and attraction for science centres and museums in North America. The CMN is also developing and facilitating the production of new documentaries with partners.

As part of its new strategic direction, the CMN is coordinating a consortium of natural history museums in Canada. The consortium is in its inaugural year and will establish its means of governance and priority areas for collaboration, such as research, collection development and access, exhibition development and educational programming. The initial working group comprises 11 institutions from all regions of Canada.

As an example of how the consortium may operate, many of the provincial museums partnered with the CMN, Environment Canada (which is providing funds), and Agriculture and Agri-Food Canada (which is providing key technical support) to produce a distributed data base of bird collections in Canadian institutions. The initiative also included a new format to enter nest sightings, essential data in management practices. The information includes several hundred thousand records and is available through the Web site of the Canadian Biodiversity Information Facility (**www.cbif.gc.ca**).

On the federal scene, the Museum continues to chair the Federal Biosystematics Partnership (FBP), comprising representatives from the AAFC (Eastern Cereal and Oilseed Research Centre), Environment Canada (Biodiversity Convention Office), Fisheries and Oceans Canada, Natural Resources Canada (Canadian Forest Service), and Parks Canada. The FBP advocates support for systematics expertise and bioinformatics within Canada, by promoting research funding, encouraging educational efforts, facilitating projects that are beyond the scope of any one agency, and acting as a Canadian focal point for international activities.

The FBP also represents Canada on the Governing Board of the Global Biodiversity Information Facility (GBIF), an international agency (**www.gbif.org**) that facilitates the development and use of bio-informatics tools and the sharing of biodiversity data. As an example of our national node to GBIF, Canada established a data portal with some preliminary data sets (the Canadian Biodiversity Information Facility, noted above).

In the future, the FBP will promote a more comprehensive work program to stabilize and enhance federal biodiversity science, including bio-informatics, in Canada. The Partnership completed a federal needs assessment, funded by the Canadian Information System for the Environment. Results indicate that long-term trends have produced serious gaps in human resources, operating funds and in strategic horizontal alignment (e.g. in informatics). Late in 2002, a formal presentation urging stronger Government of Canada support was made to the Assistant Deputy Minister's Nature Subcommittee, which accepted the proposal but requested more detail to include additional input from Health Canada and from the CFIA.

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THE 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 delivers its mandate through dedicated service lines: Space Science; Human Presence in Space; Earth and Environment; Satellite Communications; Generic Space Technologies; Space Qualification Services; and Space Awareness. The year 2002 was an active one for the Canadian Space Program (CSP).

Space Science — Canada's first science satellite in more than 30 years, SCISAT1, was unveiled. Scheduled for launch in spring 2003, SCISAT1 will help scientists measure and understand the chemical processes that control the distribution of ozone in the Earth's atmosphere. It will help improve the understanding of the depletion of the ozone layer, with a special emphasis on the changes occurring over Canada and in the Arctic. The CSA also unveiled its first micro-satellite-based space telescope, MOST (Micro-variability and Oscillations of Stars), which is scheduled for launch in April 2003. No bigger than a large suitcase, MOST will take ultra-precise measurements of the varying brightness of stars, allowing scientists to probe the atmospheres of planets beyond our solar system, measure the ages of stars and set a limit on the age of our universe. Finally, the CSA started to work with its international partners to determine the most appropriate role for Canada in future Mars missions. Canadian industry and the scientific community are working with the CSA to assess the design, development and use of laser-based sensor technology to land spacecraft on the surface of Mars. As a world leader in robotic technologies, Canada will also be considering its role in the development of a robotic mining device that will extract samples of the planet's subsurface and prepare them for scientific study.

Human Presence in Space — Along with the United States, Russia, Japan and the European Space Agency (ESA), Canada is one of the five major partners in the International Space Station (ISS), the most ambitious international science and engineering project ever undertaken. Assembly of the ISS continued to fascinate the world in 2002, as Canadarm2 was used to install Canada's new work platform, the Mobile Base System (MBS), on the U.S.-built Mobile Transporter. The Transporter will eventually move the base along 109 metres of rail stretching from one end of the ISS to the other. The MBS will play an essential role in assembling and maintaining the Station over its lifetime. Capable of carrying payloads weighing 20 900 kilograms, the MBS will transport Canadarm2, as well as ISS structures and space experiments. Astronauts will also use the Mobile Base to store tools and equipment needed during space walks.

E**arth and Environment** — CSA celebrated the historic seventh anniversary of the launch and operation of RADARSAT-1. Flying a full two years longer than its predicted operational lifetime, RADARSAT-1 continues to image the Earth, delivering invaluable data and products to professionals working in the fields of agriculture, cartography, hydrology, forestry, oceanography, ice reconnaissance, coastal surveillance, geology, environmental monitoring, and disaster response and mitigation. The RADARSAT-2 program has reached a key milestone in its development after undergoing a mission critical

design review. RADARSAT-2's Bus, Payload and Ground Segment went through a number of critical design reviews, marking a point in the process where the design is approved and manufacturing can be completed. With this next-generation commercial synthetic aperture radar satellite, the CSA is positioning Canada as a leader in Earth observation. Finally, the CSA has signed an arrangement with the ESA, covering Canada's participation in the Global Monitoring for Environment and Security (GMES). This agreement will provide new opportunities for the Canadian space industry and scientists. The GMES is aimed at developing new tools and applications to support the monitoring of the global environment, as well as hazard and crisis management.

Satellite Communications — Linking students and scientists from across our nation to cultivate knowledge in science, 350 Canadian students were connected via the Communications Research Centre (CRC) in Ottawa, for an interactive virtual-learning event hosted by guest educator and CSA astronaut Steve MacLean. Using computer-based and satellite networks to connect students from Newfoundland and Labrador, Quebec, Ontario and Alberta, the CSA astronaut guided them through the science of building structures in space. He interacted with each participating site, sharing his science expertise and passion for space exploration during the hands-on, problem-solving portion of the event. The Virtual Classroom Program, developed by CRC with the National Research Council Canada, provides unique opportunities for students from kindergarten to grade 12, in different parts of Canada and the world, to interact in real time and to increase their knowledge by debating issues, solving authentic problems and participating in desktop collaborative work through broadband real-time, multipoint conferencing.

Generic Space Technologies — The CSA awarded contracts to Canadian space companies for the development of generic small-satellite and micro-satellite buses to meet the future needs of the CSP. This marks the launch by the CSA of a small- and micro-satellite program that will spearhead Canadian satellite mission activities for the next 10 years. The program includes the cost-effective development of a satellite platform designed to accommodate S&T-demonstration missions. These leading-edge Canadian space companies will develop and improve small- and micro-satellite bus design and integration capabilities in Canada. They will also increase the S&T content on future satellite missions, fostering public–private sector partnerships and alliances.

Space Qualification Services — Just two months after supporting the launch of ENVISAT, ESA's biggest Earth observation satellite, operations personnel at CSA's Satellite Operations monitored the launch of another satellite from the Control Centre in Saint-Hubert, Quebec. Telemetry data was received from the Ariane-4 rocket that launched SPOT-5, the latest generation of the French space agency's Earth observation satellites. Following the launch, CSA's Tracking, Telemetry and Command station in Saskatoon began monitoring the satellite during the balance of the launch and the early-orbit phase. The data received from the rocket launcher allowed engineers to ensure that the satellite would make it safely to its destination in orbit. By expanding and strengthening its expertise in telemetry and tracking, the CSA is developing a new business activity that allows Canada and its space industry partners to remain leaders in the competitive market of satellite monitoring.

Space Awareness — The CSA's Space Science Program awarded three prestigious scientific scholarships, providing Canadian university students with the opportunity to participate in summer programs at NASA. Two of the selected candidates were sent to a six-week intensive training program at the John F. Kennedy Space Center in Florida. The other student was the recipient of the space Exploration Astrobiology Scholarship, which allows one Canadian university student to participate in a 10-week summer internship at the NASA Ames Research Center in California. CSA's first annual Space Educators' Training Event took place at the John H. Chapman Space Centre. Over the course of this three-day conference, educators from across Canada were treated to presentations and hands-on workshops on the themes of Space Exploration and the Human Body in Microgravity, Forces and Motion, and Ecosystems. This initiative provided educators from across Canada with the opportunity to learn from leading CSA scientists and engineers. The educators, in turn, will bring the fascinating world of space science to classrooms across the country and help students learn even more about S&T.

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DEFENCE RESEARCH AND DEVELOPMENT CANADA

Defence Research and Development Canada (DRDC), an agency of the Department of National Defence, provides the Department with leading-edge products and services in defence-related S&T. With more than 50 years of knowledge-base development covering a broad spectrum of technologies, it has solid links and an excellent reputation in the international and national S&T communities. It draws upon these relationships and its own expertise to provide the Canadian Forces and the Department of National Defence with many world-class capabilities.

DRDC is made up of Corporate Services and Programs centres co-located at the corporate office in Ottawa and six national research centres.

Major Achievements

Excellence and Innovation in S&T

DRDC scientists are recognized internationally as world leaders in several defence technology areas, including chemical/biological defence, human performance, novel energetic materials, electronic warfare, countermine technologies, surface wave radar and towed array sonar. A recent example of this recognition is the call made to DRDC Suffield by the U.S. Center for Disease Control, to test the air in the Brentwood Postal facility for traces of anthrax and to assess the danger of operating in that environment. The DRDC team was the only foreign team requested to help.

The many awards bestowed on DRDC staff by national and international organizations are further evidence of its impact and recognition. In 2001–02, 15 of its scientists were awarded international achievement awards. For the fourth time in three years, DRDC won an award from the Federal Partners in Technology Transfer.

Meeting Client Requirements

Ultimately, the most important results of defence R&D are new or improved equipment, tactics, processes and procedures, as well as technological and S&T policy advice. The following are examples of Innovation Solutions for the Canadian Forces:

- The Canadian Integrated Biochemical Agent Detection System is the first commercially available broad-spectrum chemical/biological warfare agent detector capable of autonomous operation. General Dynamics Canada markets this system commercially as "4WARN."
- The High Frequency Surface Wave Radar, installed at Cape Race and Cape Bonavista, Newfoundland and Labrador, detects low-flying, over-the-horizon targets and surface ships.
- The Logistics Analysis model developed by Operational Research scientists resulted in a $10-million saving for the Hercules fleet.
- Army gear developed under the Clothe the Soldier program was ranked highest in user satisfaction in a Canadian Forces survey on quality-of-life issues.

The Technology Investment Strategy

The Technology Investment Strategy (TIS) outlines the R&D that DRDC will undertake to develop the S&T capacity needed for future defence and national security. The TIS is based on 21 R&D activities that span the defence technology spectrum. It was updated in 2002 to better reflect technologies that are integral to the revolution in military affairs, including information technology and sensors, and projected advancements in areas such as nanotechnology, biotechnology, material sciences and power sources.

Using New Models for R&D Delivery

The Technology Investment Fund (TIF) is a competitive program whereby the funding of proposals from scientists is based on external scientific peer review and the potential impact on future defence operations. This program currently sponsors 32 R&D projects. Examples of significant outcomes from TIF projects include the following:

- Display Techniques for Battlespace Visualization, which allows decisions to be made more quickly without sacrificing accuracy;
- Remote Detection of Radiological Threats;
- Hydrogen Storage in Small Nanotubes; and
- a new directional crystal growth technique for Magnetic Shape Memory Alloys, which promises lower-cost actuators.

The Technology Demonstration Program is designed to contribute to defence modernization by demonstrating the use of technology for defence solutions. One of the first projects was MILSATCOM Performance Enhancement, which had as its objective the development of a unique Canadian technology for military communications satellites by increasing their bandwidth. A commercial version of the technology is being built for the Telesat Canada Anik F2 satellite.

Projects started in 2002 include Force Protection Against Enhanced Blast. This project focusses on new methodologies to protect against the threat of enhanced blast. It includes characterization of the blast environment from enhanced blast weapons and the development of countermeasures and protective measures that minimize blast effects.

A Technology Outlook Thrust has also been initiated to identify emerging technologies, assess their potential relevance to Canadian defence, and provide advice on the impact of S&T developments on national and departmental policies and strategies. As part of Thrust, DRDC co-sponsors symposia/workshops to place new and emerging issues in S&T on the strategic defence agenda. A joint symposium on knowledge management was held with other DND groups in September 2002 to develop a departmental strategy for knowledge management.

The Defence Industrial Research (DIR) Program supports, at the 50-percent-funding level, eligible research from the Canadian private sector that has a sufficient level of defence relevance to Canada and/or its allies. Some examples of successes resulting from research supported under the DIR Program include:

- LED flat panel displays from General Dynamics Canada, installed in Canadian Coyote vehicles and U.S. Abrams tanks;
- High-temperature super-conductive electronic devices from COM DEV launched on the U.S. ARGOS satellite;
- Plasma Furnace Waste Destructors developed for the U.S. Navy by Pyrogenesis;
- Ceramic Sonar Transducers for the U.S. Navy by Sensor Technology Ltd.; and
- a combined Immersion/Anti-gravity Suit for the Boeing F-22 Raptor aircraft by Mustang Survival Corporation.

Enhanced Collaboration with Partners

Through The Technical Cooperative Program, DRDC has a long history of partnering, especially with our international allies, the North Atlantic Treaty Organisation (NATO), and through bilateral and trilateral agreements. In the past year, DRDC initiated three new collaborative technology demonstration projects with international partners: Unmanned Airborne Surveillance (with the United States), Soldier Integrated Headwear System (with NATO), and the Force Protection Against Enhanced Blast (with the United Kingdom).

The special relationships that exist between Canada and the United States have seen the successful development, commercialization and exploitation of many technologies and systems. The unique position that Canada enjoys in defence science creates favourable conditions for Canadian industry to access defence programs in the United States. Examples of current projects include:

- the Advanced Distributed Mission Trainer to develop and demonstrate a new generation of cost-effective, distributed air combat simulations;
- the Coalition Aerial Surveillance and Reconnaissance (a multinational project), which integrates different forms of surveillance information and processes to provide an improved coalition operational picture to the war fighter and ensure interoperability among allied nations; and
- the Hard Chrome Alternative Technologies to adopt high-velocity, high-temperature jet spray coating technology for certain aircraft components.

Security and Counter-Terrorism

On the national S&T scene, DRDC has played a leading role in the development of the Federal Innovation Networks of Excellence (FINE), in which Government of Canada labs, universities and the private sector are networked under federal leadership to augment and integrate Canada's S&T capacity. DRDC leads a pilot project for FINE called the Chemical, Biological, Radiological and Nuclear Research (CBRN) and Technology Initiative, on behalf of the federal S&T community. CRTI's fund of $170 million over five years was established in the December 2001 federal budget. The initiative will strengthen the nation's preparedness for a CBRN terrorist attack by investing in research and technology that supports the development of new capabilities in CBRN preparation and response.

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ENVIRONMENT CANADA

Environment Canada (EC) wants to see a Canada where people make responsible decisions about the environment, thereby sustaining it for the benefit of present and future generations. EC also helps Canadians adapt to their environment in ways that safeguard their health and safety, maximize economic activity and enhance environmental quality. These goals can only be achieved if the Department is successful in generating, acquiring, disseminating and improving the use of our knowledge to deliver innovative and responsive services and decision making within EC and to Canadians. Continuously improving how our science and policy are linked together is key to our service to Canadians.

Following is a summary of the status of EC's implementation of the Framework for Science and Technology Advice and provides some examples of how EC uses its science.

EC Implementation of the S&T Advice Framework Measures

The Framework implementation measures identify the tools and organizational and support structures required to address accountability, evaluation and reporting to better align with the Framework. EC's implementation of the Framework proceeded on two tracks: within the department, and across the government. For information on the interdepartmental implementation activities, please see Chapter 3 in the main body of the report.

Early in the process, EC developed its own plan to guide the adoption of the Framework for S&T Advice. This plan incorporates recommendations on better linking science and policy, and includes activities to address the implementation measures specified in the Framework.

Promoting the Adoption of the S&T Advice Principles and Guidelines

The effective use of S&T advice in making policy and regulatory decisions is a high priority for EC. Several tools to help promote the Framework and the adoption of the S&T Advice principles and guidelines have been developed.

EC and Natural Resources Canada worked together to design a course on S&T advice in the policy process. The course offered an opportunity for representatives from both the science and policy communities to meet and share their points of view in relation to actual case studies.

An on-line resource tool known as SPI (Science Policy Integration) is also being developed. This tool should enhance understanding of the Framework at the working level and start addressing cultural differences by sharing common terminology, tools and resource materials. Four departmental case studies have been developed for this tool.

Ensuring Accountability

Within EC, a senior-level S&T Assistant Deputy Ministers' committee has been designated as S&T Advice Champion. EC Business Line tables,[1] other tables, institutes/research centres and program leads are accountable for implementing the Framework.

To help strengthen this approach, a science advice checklist for Cabinet documents has been developed interdepartmentally. EC helped validate this checklist by developing a working example. This tool is being communicated within the department, and its collaborative use with other similar departmental tools will be promoted.

Evaluating Effectiveness

EC has conducted a number of studies to determine its readiness to implement the Framework for S&T Advice, as well as to identify challenges in linking science to policy. Overall, these studies found that EC has been successful in incorporating S&T advice considerations into its planning and decision-making processes. These studies helped evaluate initial adherence to the Framework principles. Further work is planned by the Business Line tables to validate the findings from these studies, address challenges and ensure continuous alignment with the Framework.

EC Science in Action

S&T is an integral part of EC and serves as the basis for departmental policies, programs and services. EC has witnessed many changes and challenges in recent years. Environmental issues have become more global in scope, and the Canadian public has become increasingly knowledgeable and concerned about environmental issues. As a result, the need to

1. EC Business Line tables are responsible for the delivery of EC programs and are composed of representatives from science and policy communities, and the regions.

focus on the principles and guidelines outlined in the Framework for S&T Advice, to ensure effective science-based decision making, has increased.

Science assessment and impact analysis are the major mechanisms for bringing sound science advice to bear on policy and decision making at EC and elsewhere. These assessments contribute to the development of effective policies by providing policy and decision makers with advice based on sound science, and help to ensure that EC science has an impact. For example:

- An international peer review of Meteorological Service of Canada's (MSC's) R&D performance was done by a panel made up of scientific experts who reviewed the quality, relevance and impact of their R&D. The review concluded that while the R&D environment and some management and program issues remain challenges for the future, the MSC R&D program is fundamentally sound and contributes to the needs of EC and Canadians.
- EC is working with the granting councils (SSHRC, CIHR and NSERC) to develop environmental research agendas in their respective jurisdictions, as a first step towards the development of a national environmental research agenda.
- The National Water Research Institute has strengthened its science-policy capacity and, working with the Canadian Council of Ministers of the Environment, organized a series of workshops to improve provincial and territorial input to federal water-research priorities, and decision-maker and stakeholder awareness of research results.
- The EC Laboratory Coordinating Committee drafted the Laboratory Data Quality Policy, which will enable the Department to ensure that all analytical data generated or received meets consistent high standards of quality.
- The Environment Technology Centre (ETC) provides specialized scientific support and undertakes R&D for environment protection programs. The Centre focuses on four main areas:
  - — technologies for measuring air pollutants in ambient air and from mobile and stationary sources;
  - — analysis of a wide variety of organic and inorganic compounds in diverse samples;
  - — assessments and clean-up of contaminated sites; and
  - — prevention of and response to pollution emergencies such as oil and chemical spills.
- An international air quality study in the lower Fraser Valley of southwestern British Columbia provided a better understanding of the sources, formation and distribution of particulate matter and ozone, to provide credible guidance on strategies to reduce the risks to human health and the environment associated with these pollutants.

Partnerships, collaboration and volunteers all play an important part in EC's strategy for conducting S&T. Through S&T partnerships, the Department builds synergy with other organizations, levers resources, enhances human resource development, promotes the use of R&D results, and draws on S&T expertise in other sectors. S&T partnerships support EC's policy and service capabilities, as well as enhance and supplement human and financial resources. For example:

- Canadian and U.S. governments, working together on the Georgia Basin–Puget Sound ecosystem, have recently developed a report on six ecosystem indicators that measure shared stresses on both sides of the border.
- Through the Atlantic Environmental Prediction Research Initiative in Halifax, EC scientists work in collaboration with government, industry, and academic partners on such important projects as the life-saving storm surge model.
- EC also regards Canadian volunteers as the eyes and ears of the department, improving its knowledge and understanding of the environment. Volunteers count birds, listen to and record information on frogs, gather weather data, and contribute through a host of other activities.

Taking advantage of increased interest in the environment and the science that supports environmental decision making, EC is working to ensure that science and information are made available to stakeholders and the public.

- The National Pollutant Release Inventory provides Canadians with information about pollutants being released in their communities to empower them to ask good questions and to work with industry to reduce emissions at the local level.

- The *Canadian Environmental Protection Act* Registry is a comprehensive, on-line source of public information relating to activities under the Act. The primary objective of the Registry is to encourage and support public participation in environmental decision making.
- Under the *Canadian Environmental Assessment Act*, the Environmental Assessment (EA) Program provides expert scientific and technical advice to federal and provincial departments. This process is accessible to the public through the Federal Environmental Assessment Index, public notices and panel reviews. The EA program is currently testing the EA Science Forum, an intranet site that enables EC EA practitioners and scientists to share knowledge on EA science issues and on R&D activities. This work includes identifying science gaps for further research.
- The MSC, on behalf of the Government of Canada, collects climate and hydrometric observational data from various digital and paper sources, contributes to the quality checking of the climate data, and archives the data in digital format. These climate and water products are a valuable resource for researchers, educators and the Canadian public.

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FISHERIES AND OCEANS CANADA

The Science Program is the cornerstone of the mandated responsibilities of Fisheries and Oceans Canada (DFO). These responsibilities, which derive from various acts of Parliament, cannot be successfully implemented without the scientific knowledge and advice that the Science Program produces. The Department's mandated responsibilities are as follows:

- policies and programs in support of Canada's economic, ecological and scientific interests in the oceans and freshwater;
- the conservation and sustainable utilization of Canada's fisheries resources in marine and inland water; and
- safe, effective and environmentally sound marine services responsive to the needs of Canadians in a global economy.

Through its support of the Department's mandated responsibilities, the Science Program provides unique benefits to Canadians such as:

- Management and protection of fisheries resources — by providing advice on marine fish stocks and total allowable catch;
- Protection of the marine and freshwater environment — by providing information on marine ecosystems and advice to support fish and shellfish habitat management decisions on major development projects;
- Understanding of the oceans and aquatic resources — by producing scientific knowledge and advice for the issuance of permits under the *Navigable Waters Protection Act*, aquaculture siting, and the integrated management of oceans resources and uses;
- Maritime safety — by producing hydrographic charts and products and by providing knowledge and advice on tides, storm surges, currents, ice, and water levels;
- Maritime commerce and ocean development — by providing research and advice regarding aquaculture fin fish and shellfish species; and
- Consumer confidence in seafood products — by providing support for health and habitat protection.

What follows is a sample of some of the important initiatives undertaken by the Department in 2002, further illustrating the significance of DFO Science domestically and internationally.

DFO recently established a centre at the Bedford Institute of Oceanography in Nova Scotia to coordinate Canada-wide research into the environmental and oceanographic impact of offshore petroleum exploration, production and transportation. At this new Centre for Offshore Oil and Gas Environmental Research, DFO scientists will build on existing Canadian and international scientific knowledge and expertise to support DFO's role in recommending environmentally sound guidelines for oil and gas exploration and production in Canadian waters.

The National Contaminants Information System was implemented. This national repository of data on toxic chemicals contains information on metals, PCBs, dioxin-furans, pesticides and other contaminants. The archive

includes information such as 20 years of data on PCB levels in four- and five-year-old lake trout, a popular recreational fish. This data management system, the first of its kind in Canada, will soon be available on the Internet.

The Canadian Surface Ocean Lower Atmosphere Study (SOLAS) Network represents a leading national program in support of the newly approved international SOLAS project under the auspices of the International Biosphere Geosphere Program. Scientists from Canada and five other countries will undertake 15 coordinated projects designed to better understand the processes involved in air–sea interactions and their relation to climate change. In the summer of 2002, the Canadian SOLAS Network conducted an experiment in collaboration with Mexico and Japan. Findings from this research contribute to the international pool of knowledge on climate change and related issues.

The Joint Western Arctic Climate Study (JWACS) has brought together scientists from several departments and universities in Canada and Japan to develop a multiyear research program in the Western Arctic Ocean. JWACS is expanding research efforts in the Arctic to understand climate variability and change. Moreover, it demonstrates the feasibility of pooling expertise and infrastructure from different countries to address broad scientific issues that are beyond the means of any single country.

The conservation and protection of fish and sustainable fisheries are based on an understanding of how fish habitat supports fish and how human activities affect fish habitat. For some small-scale human activities, such as building a dock, DFO has developed user-friendly computer models for the review of project proposals. Ultimately, Canadians will be able to use these computer models when designing their own projects to further streamline decision making and approval processes. A similar program is also being developed to streamline the review of environmental variables in the siting of aquaculture operations.

The Canadian Hydrographic Service has established ISO 9001 accredited processes to enable delivery of more cost-effective navigational products. One innovation was the implementation of a Print-On-Demand service, which provides the latest navigation products, such as nautical charts, to the commercial and recreational marine community.

To support the provision of accurate scientific data on Canada's ocean floor, acoustic classification technology using multibeam sensors has been developed in conjunction with industry. This technology will be particularly useful for mapping of the sea floor habitat and will be essential in any future territorial claim to the continental shelf under the United Nations Convention on the Law of the Sea.

The Department continues to refine existing science advisory processes and implement initiatives that reflect the intent of the Framework for Science and Technology Advice.

The Canadian Science Advisory Secretariat (CSAS) **(www.dfo-mpo.gc.ca/CSAS/Csas/English/Index_e.htm**) within DFO coordinates the peer review and provision of advice on scientific issues for the Department. Until recently, this formalized peer review process was solely applied to scientific information and advice generated in support of decision-making requirements related to the management of individual fish stocks. Given the attributes of this well-developed, formalized peer review process, the mandate of CSAS has been expanded to provide scientific information and advice on a number of issues, including but not limited to the impacts of oil and gas developments, the location of aquaculture sites, marine protected areas and species at risk. Through expansion of the CSAS mandate, scientific information and advice on these and other issues will be subjected to consistent CSAS national standards and methodologies in keeping with the priorities and guidelines contained within the Framework for Science and Technology Advice. Recent refinements to the CSAS process include the establishment of guidelines for external participation in the peer review process, to clarify the objectives, the role and requirements of external participants. National standards have also been revised to enhance external participation in the shaping of the terms of reference for issues under examination and increased participation in scientific debate. These refinements have resulted in improved transparency and openness, inclusiveness and issue definition.

Building on departmental and government-wide initiatives for the application of the precautionary approach, DFO has developed and adopted a framework of explicit Conservation (Limit) Reference Points and associated harvest control rules. Starting with cod stocks in Atlantic Canada, DFO Science has commenced setting the quantitative values for conservation

limits, and is working with other sectors in the Department to develop and evaluate Harvest Control Rules to manage risk relative to these limits. Operationalizing the precautionary approach will ultimately lead to the improved quantification and communication of scientific uncertainty and risk in the decision-making process, as it applies to the management of Canada's fisheries.

As a science-based department, Fisheries and Oceans Canada has been challenged in recent years with a decline in public confidence. While Canadians' confidence in the Department's ability to conduct scientific research and provide scientific advice has begun to increase, the ongoing alignment of science advisory processes with the Framework for Science and Technology Advice continues to be an important component of the Department's efforts to restore the confidence of Canadians.

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FOREIGN AFFAIRS AND INTERNATIONAL TRADE

Summary of the Science and Technology Program, 2002

Throughout 2002, the Department of Foreign Affairs and International Trade (DFAIT) focused its departmental resources in S&T through its network of S&T Officers abroad, and its Science and Technology Division (TBR) by:

- building partnerships with other government departments and agencies;
- chairing the Interdepartmental Network on International Science and Technology (INIST);
- helping Canadian technology-based companies and research institutions establish international R&D collaborations, including venture financing, with targeted countries;
- developing new S&T communications tools and products;
- managing strategically key bilateral relations (including four active treaty-level S&T agreements with Japan, France, Germany and the European Union) in partnership with the Canadian scientific and business communities; and
- enhancing Canada's profile at international S&T events.

Over the course of 2002, the Department worked increasingly with the INIST as a forum for coordinating international S&T issues of common interest among participating SBDAs. The INIST held four general meetings to discuss issues such as the S&T relationship with Korea and the European Union. Special INIST working group meetings were also held in France, Japan, and the issue of funding for international S&T.

The area of R&D business development saw a significant expansion of activity with close to 25 international technology and venture capital partnering events organized.

Key 2002 Results Achieved by DFAIT's S&T Program

International R&D Business Development

Major initiatives were conducted in partnership with federal and provincial government departments, foreign governments, and selected foreign industry associations and financial institutions as follows:

Information Technology and Telecommunication (IST) Sector — IST-Europe Canada (IST-EC) was created in 2002 as a framework to facilitate partnerships between Canadian and European researchers in the fields of IST. IST-EC partnering events and other partnering initiatives included the following:

- e-Security and e-Privacy Workshop — Montebello, Quebec, May 30–31, 2002.
- e-LearnExpo — Vienna, June 20–21, 2002.
- e-Work Conference — Paris, September 25, 2002.
- International Federation for Information Processing World Computer Conference — Montréal, August 26–30, 2002.
- IST-2002 Conference — Copenhagen, November 4–6, 2002. (This is an annual conference where all European partners in EU projects meet.)
- Technology Partnering Forum — Singapore, June 18–21, 2002. (Held during CommunicAsia and BroadcastAsia.)
- S&T Partnering Seminar — Berlin, February 18, 2002. (Photonics and lasers in conjunction with the Team Canada 2002 Mission to Berlin.)

Life Sciences Sector — TBR focusses on its resources on biotechnology in human health. The Division's activities in this sector in the past year included:

- Biotechnology Partnering Seminar — Berlin, February 18, 2002. (Held in conjunction with the Team Canada Mission to Germany.)
- Four technology partnering events and one networking dinner — Toronto, June 8, 2002. (Held for the global venture capital community at the BIO 2002 Conference and Exhibition. Participants included Canada–Europe, Canada–Asia, Canada–Australia/New Zealand/United Kingdom, and Canada–Israel).
- Biotechnology Venture Financing and Technology Partnering Seminar — Zurich, February 26, 2002. (Held under the sponsorship of SWX Swiss Exchange.)
- Biotechnology Venture Financing and Technology Partnering Mission — Tokyo, Taipei, Singapore and Seoul, March 11–22, 2002.
- Biotechnology Partnering Mission — Stuttgart, November 10–15, 2002. (Held in conjunction with BioEurope 2002, with site visits to Lausanne and Basel, Switzerland.)
- Technology Partnering Seminar in collaboration with Industry Canada — Dusseldorf, November 21, 2002. (Held at MEDICA 2002.)
- Panel session on international financing — Québec City, October 2, 2002. (Held at BioContact 2002.)

Advanced Materials Sector — The advanced materials sector includes a wide spectrum of new-materials technologies that have applications in almost all strategic sectors of the economy such as information and communications technologies, biotechnology, environment (ecomaterials, ecoprocesses and ecodesign), energy and aerospace. TBR focussed its activities in the field of advanced materials in 2002 in the following areas:

- Technology Partnering Mission — Tokyo, February 1–13, 2002. (Held in conjunction with the International Workshop on Eco-materials and Eco-design.)
- Canada-Japan Workshop on Eco-materials and Eco-design — Vancouver, March 13–15, 2002. (Held in conjunction with GLOBE 2002.)
- Electronic and Optoelectronic Materials Technology Partnering Mission to China — June 6–16, 2002. (Held in conjunction with the International Union of Materials Research Societies conference.)
- Nanomaterials/Nanotechnology Partnering Mission — France, Germany and Switzerland, November 16–30, 2002.
- Composite Materials Technology Mission — Paris, April 8–12, 2002. (Held at Journées Européennes des Composites.)
- Incoming French Intergovernmental Exploratory Mission on Advanced Materials to Canada — June 17–24, 2002.
- Incoming French Expert Mission on Micro-Nano Technologies to Canada — August 26–September 7, 2002. (Held in conjunction with CANEUS — Canada–USA–Europe Workshop on MNTs in Space, Aeronautics, Defence and Industry.)
- Canada–U.S. Partnering Workshop on Smart Materials and Structures — Montréal, October 10–11, 2002.

Venture Capital Sector — TBR's venture capital program contributes to the overall objective of increasing the supply of venture capital available to Canadian firms, as underlined in *Canada's Innovation Strategy* launched in February 2002. In October and November 2002, TBR supported venture capital financing events in Ottawa and Vancouver. In total, 65 growing Canadian companies showcased their capabilities to Canadian and foreign financial institutions.

S&T Policy and Institutional Linkages

Major initiatives conducted with INIST guidance and support include:

Canada–Korea S&T Arrangement — On July 5, 2002, on the recommendation of INIST, DFAIT and the Ministry of Science and Technology of the Republic of Korea signed a Science and Technology Arrangement to advance cooperative S&T activities. Funding can now be accessed more easily by Korean researchers for collaborative research projects with Canada.

Bilateral S&T Agreement Meetings — A Canada–Japan mid-term meeting was held in Tokyo, April 19, 2002, to discuss ways to enrich our S&T relationship, in particular to promote the involvement of the private sector in collaborative projects under the agreement.

A Canada–Germany mid-term review meeting was held in Ottawa, October 16, 2002, following a successful sixteenth Canada–Germany Science and Technology Consultation and the celebration of the thirtieth anniversary of the Canada–Germany Science and Technology Agreement in October 2001.

Canada–France — A Canadian delegation, composed of representatives of Networks of Centres of Excellence, participated in the eleventh SITEF (Salon International des Technologies Avancées) exhibition in Toulouse, October 23–26, 2002, and met with their French counterparts from the Réseaux de recherche et d'innovation technologique at a first Canada–France Network meeting.

Canada's Delegation to the EU Sixth Framework Programme (FP6) Launch — DFAIT led a Canadian delegation of 50 participants to the European Union's (EU's) FP6 launch and the European Research 2002 conference in Brussels, November 11–13, 2002. Canada had an exhibitor's booth and held a successful information session. The FP6 launch was used to promote Canada as a world leader in research, share its extensive experience with a network-based research model — a model that the EU is adopting under FP6 — and highlight its new Canada–EU S&T Web site (**www.infoexport.gc.ca/science**).

Canada–European Union S&T Summit Statement — Canada and the EU agreed on a list of priority areas for S&T collaboration at the Canada-EU Summit held in Ottawa, December 19, 2002.

Canada–Brazil — An exploratory Canada–Brazil mission was undertaken in June 2002, with the National Research Council Canada, resulting in the identification of potential opportunities for Canada–Brazil scientific cooperation and a proposal to hold a bilateral Canada–Brazil Science and Technology Roundtable in 2003.

Science and Technology Counsellors' Tour — Canada's six S&T counsellors, from Berlin, Washington, Tokyo, Brussels, London and Paris, as well as trade commissioners with S&T responsibilities from Singapore and Seoul, travelled to Canada to meet with the S&T community, May 6–17, 2002. Western Canada was a particular focus for the tour.

Going Global S&T Fund — DFAIT's TBR administers the "Going Global S&T Fund" to assist Canadian researchers in establishing new international collaborative R&D initiatives with foreign counterparts. In 2002, 16 projects — with many including groups of researchers from university, industry and government — were supported by this program.

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HEALTH CANADA

Health Canada is mandated to help the people of Canada maintain and improve their health and safety. Under the *Pest Control Products Act*, it is also mandated to protect the environment. Health Canada uses science performed in-house as well as science performed by a network of national and international science organizations to support its policies, regulations and programs, and to respond to emerging challenges and opportunities critical to the health and safety of Canadians.

Health Canada's capacity to perform, harness, translate and use sound science to support evidence-based decision making is critical to the Department's goal of optimizing health outcomes and minimizing health risks for Canadians. Two frameworks have been established to ensure that the Department has access to and effectively uses science and science advice. The Framework for Science enables all parts of the Department to work together in identifying, conducting and harnessing the science required to fulfill its mandate and address emerging issues. The Health Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks provides the means for the Department to bring together science, policy and a range of other factors in an inclusive, iterative process to ensure effective risk management and evidence-based decision making.

Framework for Science
In 2002, the Office of the Chief Scientist developed the Framework for Science, which provides a process to identify Health Canada's science requirements and ensure that a balanced portfolio of science activities supports the Department's diverse roles and responsibilities. The Framework will ensure that the full range of science performed and used by Health Canada meets standards for effective science. The Framework will result in a comprehensive departmental five-year science plan to ensure that Health Canada performs, and has access to, the critically important science needed to fulfill its

mandate and deliver its programs. Implementation of the Framework involves an open and inclusive approach that engages scientists, policy analysts, those involved in service and program delivery, and management at all levels of the Department.

Health Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks

In 2000, Health Canada adopted the Health Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks (DMF), which resulted in a new approach to risk management. The DMF (**www.hc-sc.gc.ca/hpfb-dgpsa/hcrisk_cp_e.html**) is Health Canada's main mechanism to ensure adherence to the principles and guidelines outlined in the Framework for Science and Technology Advice.

The DMF is based on a series of principles and organizational values, and consists of interrelated steps, including issue identification, risk assessment and risk management. The DMF and its guidance documents are intended to provide a common basis for risk management and decision making applicable to the range of issues that fall within Health Canada's mandate. The DMF is not an implementation manual; rather, it is the overarching framework that guides the development of tailored procedures to meet the particular needs of individual programs.

The DMF ensures a consistent approach, clear identification of issues, and the development and application of sound science advice. It reflects greater openness and transparency through the involvement of interested and affected parties throughout the process, including partners, the public and other stakeholders. It also calls for a precautionary approach to decision making.

The DMF has led to improved cooperation among scientists and policy analysts. In addition, an executive-level risk management committee ensures an active role of senior management in the review of risk assessment and analyses, and in making evidence-based decisions.

Science and Technology Accomplishments, 2002

The Framework for Science and the Health Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks are becoming increasingly integral to the way Health Canada conducts science and develops policy. The following highlights of the Department's scientific contributions demonstrate the importance of science and its integration into policy and decision making:

- The Centre for Infectious Disease Prevention and Control has developed a system for surveillance of West Nile Virus (WNV) in dead birds and mosquitoes, and enhanced WNV disease-prevention and control policies and related activities.
- In the summer of 2002, the national surveillance system for variant Creutzfeldt-Jakob disease (v-CJD) detected the first case of v-CJD in Canada. The data collected will allow Health Canada to detect and investigate cases more rapidly in the future.
- Health Canada was the first organization to identify and report on the re-emergence of the B/Victoria/2/87 lineage influenza viruses in North America. This discovery not only provided timely and valuable information to the public, but also contributed to the World Health Organization's decision to modify its recommendation on the constitution of influenza vaccines globally.
- Health Canada's National Microbiology Laboratory (NML), through its national network of laboratories for real-time early detection of naturally occurring epidemics from food and water borne infections, has already detected epidemics of E. coli H7:O157 days or weeks before traditional systems.
- With provincial public health laboratories, the NML has created a national network that is capable of rapid diagnostics of all agents considered to be a high risk for use as bioterrorist agents.
- Health Canada and provincial and community stakeholders have released *The Cost of Chronic Disease in Nova Scotia*, which links the incidence of chronic disease to socio-economic status. The report is expected to lead to more effective community-based projects in the future. (**http://gov.ns.ca/health/downloads/chronic.pdf**)
- As part of the Federal Tobacco Control Strategy, Health Canada's collaboration with Statistics Canada on the Canadian Tobacco Use Monitoring Survey has found, between the years 2000 and 2001, a reduction in smokers aged 15 and over. This survey will allow Health Canada to determine which of its anti-smoking strategies are most successful and to contribute to a further decline in people suffering from smoking-related diseases.

- Health Canada epidemiological studies have shown positive associations between ambient air levels of both particulate matter and ozone and a range of adverse health effects. As a result, Health Canada and Environment Canada have proposed adding particulate matter precursors and ozone and its precursors to the List of Toxic Substances in the *Canadian Environmental Protection Act*.
- The Water Quality and Health Bureau contributed to the development of a drinking-water guideline for the naturally occurring toxin Microcystin-LR. This guideline and accompanying research on analytical and treatment methods, and a field test kit will result in reduced risk to the public from exposure to this contaminant in drinking water.
- Health Canada laboratories developed and evaluated novel methodologies to reduce our reliance on animal models in research and testing. Toxicological studies can now be conducted with fewer, and in some cases, no animals.
- Health Canada research has ascertained that there is an increased risk of cardiovascular disease following radiation exposure.
- Health Canada has developed a detection system to identify violations of the International Nuclear Test-Ban Treaty and has developed models to predict contamination after a nuclear accident.
- The new *Pest Control Products Act*, passed recently by Parliament, will strengthen health and environmental protection with special attention to children; strengthen post-registration control of pesticides by requiring re-evaluation of older pesticides 15 years after they are registered; require pesticide companies to report any adverse effects; and provide for a more open and transparent decision-making process. This will lead to a more effective and safer use of pesticides.
- Health Canada created the Marketed Health Products Directorate to conduct post-approval surveillance, assessment and risk-management (including risk-communication) activities of all marketed health products. These activities will maximize the safety, effectiveness and quality of all health product types marketed in Canada: pharmaceuticals, biologicals, vaccines, medical devices, natural health products, radiopharmaceuticals and veterinary drug products.
- In response to the increasing concern around the world that bacteria, viruses, fungi, and parasites are becoming more resistant to antibiotics, the Veterinary Drugs Directorate is leading an integrated science and policy initiative to address Antimicrobial Resistance (AMR). This work is being done in collaboration with other branches of the department, and with other federal government departments, provincial and private sector partners and stakeholders. A key result is the Canadian Integrated Program for AMR Surveillance, which will provide data essential for the formulation of policies and actions to address this global health issue.
- The Therapeutic Products Directorate, in partnership with the Canadian Institutes of Health Research, is leading a national initiative to develop guidelines for the appropriate use of placebos in clinical trials.
- The Natural Health Products Directorate has developed a consultation workbook to facilitate the creation of comprehensive standards to evaluate the safety and efficacy claims for natural health products. This will allow consumers to make informed choices about these types of products.
- Recently, acrylamide, a carcinogen, was found to be a normal component of baked and fried foods. Scientists in the Food Directorate responded quickly and discovered the major mechanism of formation of acrylamide, which will facilitate the ability of Health Canada to develop an appropriate response to this potential risk.
- The new Nutrition Labelling Regulations will help consumers make informed food choices that can help to influence diet and reduce the risk of nutrition-related chronic diseases such as cancer, diabetes, coronary heart disease, and stroke.
- To enhance vaccine surveillance activities, minimize adverse events associated with immunization, and maintain public confidence in this valuable public health program, scientists of the Biologics and Genetic Therapies Directorate have contributed to the development and application of new separation and analytical methods for the quality assurance of influenza vaccines.

- The Office of the Chief Scientist created Health Canada's Postdoctoral Fellowship program, which will enhance Health Canada's development of science and policy research and analysis.

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INDUSTRY CANADA

Industry Canada's mandate is to make Canada more competitive by fostering the growth of Canadian business; promoting a fair and efficient marketplace; and encouraging scientific research and technology diffusion. In delivering on this mandate, it is active in S&T in many ways — as a performer, funder, enabler and policy setter.

In line with the government's commitment to connect rural and remote Canada, Industry Canada's lead research laboratory, the Communications Research Centre (CRC), launched a multidisciplinary research program in 2002, aimed at exploring ways to cost-effectively deliver broadband services to these areas via satellite, terrestrial wireless and wireline technologies. Affordability is the key to large-scale deployment in low-population-density areas. With a wealth of research expertise in all relevant technical fields, the CRC is exploring and assessing viable systems and technologies that will potentially connect remote and rural communities. While private industry is likely to concentrate on regions where population density provides for a good business case, the CRC's R&D program focusses on technologies and systems that can extend broadband service and make it more affordable to less densely populated areas.

The CRC maintains Canada's only critical mass of researchers and facilities dedicated to R&D on the technologies that form the basic telecommunications systems across Canada: radio, satellite, broadcasting, and fibre optics. It provides independent advice for public policy, builds partnerships to close innovation gaps in the telecommunications sector, builds technological intelligence, and fosters growth in SMEs.

The Shirleys Bay Campus, where the CRC is the custodian and largest resident, celebrated 50 years of innovation and ongoing collaboration in communications R&D. Working independently, with other government departments or with private sector partners, organizations at Shirleys Bay continue to develop leading-edge technologies that advance innovation in Canada and abroad.

The Canadian Intellectual Property Office (CIPO) administers Canada's intellectual property (IP) systems. CIPO's main areas of activity are patents, trademarks, copyrights, industrial designs and integrated circuit topographies. CIPO helps to accelerate Canadian economic development and social cohesion by encouraging invention, innovation and creativity. In 2001–2002, CIPO granted 12 445 patents. The largest discipline was "mechanical/civil" (3213), followed by "computer related" (2389) and "other chemistry" (1961). The increase in demand for IP, both in Canada and worldwide, has seen CIPO's patent-related workload increase significantly.

In the past year, CIPO has examined how it should better position itself, both domestically and internationally, to provide world-class service to clients. The challenge is to sustain a credible and effective role by providing competitive, modern and high-quality services comparable to, or better than, those offered by other major IP offices worldwide. CIPO is implementing a plan to strengthen service capacity by:

- hiring examiners and improving examiner training;
- preparing to provide international search and international preliminary examination services in summer 2004;
- stepping up efforts to promote Canada's international IP interests;
- improving dissemination of IP through an outreach dissemination strategy; and
- continuing investments in information technology.

Technology Partnerships Canada (TPC) is a special operating agency of Industry Canada. It contributes to achieving the Department's strategic objectives to encourage R&D and high-technology projects in Canada. TPC was created in 1996 to make strategic, critical and timely investments for R&D that promote innovation, commercialization, sustainable development and increased private-sector investment. TPC advances and supports government initiatives by investing strategically to maintain and grow the technology base and technological capabilities of Canadian industry. TPC also encourages the development of SMEs in all regions of Canada. In addition, TPC, through its partnership with the National Research Council Canada's Industrial Research Assistance Program (IRAP), supports innovation by SMEs with small-dollar-value

projects. In cases where SMEs' forecast eligible costs are $1.5 million or less, TPC's precommercialization support is delivered through IRAP's national network of Industrial Technology Advisors.

As of September 30, 2002, TPC's portfolio included 474 investments totalling $1.9 billion, which leveraged $8.3 billion in innovation spending. TPC is helping to transform great Canadian ideas into reality. It does so in emerging areas such as biotechnology, information and communications technologies, eco-efficient technologies, alternative energies, and leading-edge technologies in aerospace and defence. TPC's investments are forecasted to create or maintain more than 37 000 jobs; 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 federally funded through Industry Canada, is dedicated to the development and implementation of Canada's national genomics and proteomics research strategy. This past year, Genome Canada completed its second national competition aimed at funding large-scale research projects and their related S&T platforms. Adding to the 17 research projects funded through the first round, $155.5 million was invested in 34 additional innovative research projects with applications in health, forestry, agriculture, bioinformatics, technology development, the environment and GELS (genomics-related ethical, environmental, economic, legal and social issues). These projects were chosen through an intensely competitive process, with more than 150 international experts evaluating international competitiveness and scientific excellence in the framework of Canada's social and economic fabric.

The Precompetitive Applied Research Network (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. Industry Canada, through its focus on building the knowledge-based economy, is a key supporter of PRECARN Phase III. Phase III currently has a total of 31 research and development projects under administration.

Industry Canada is a major supporter of CANARIE, Canada's advanced Internet development organization. The highlight of the past year for CANARIE was the announcement by the Government of Canada of $110 million in funding to design and deploy CA*net 3's successor "next-generation" research and innovation network. CA*net 4 embodies new technology and new architecture that will maintain Canada's lead in the area of advanced networking. By mid-August the backbone of CA*net 4 was operational. The second general area where CANARIE's contribution has been growing in importance is its Phase 3 funding programs in e-learning, e-health and e-business.

The Technology Roadmapping (TRM) Initiative, launched by Industry Canada in 1995, plays a key role in enhancing Canadian innovation. An industry-led process that looks two-to-ten years into the future, TRM helps companies forecast and articulate the elements required to identify, select and develop technological alternatives to satisfy future service, product or operational needs. Technology roadmaps bring together players from among government, private companies, researchers and others to collaborate in a far-reaching planning process, opening the door to collaborative R&D. This past year, Industry Canada was both catalyst and facilitator in the development and completion of the Intelligent Buildings Technology Roadmap. This Roadmap focusses on commercial, institutional and high-rise residential buildings, and helps in forecasting the technologies that Canadian business will need to develop in order to continue to compete internationally. Roadmaps are currently in development in the areas of aerospace competitive intelligence, biofuels from biomass, biopharmaceuticals, clean coal, CO_2 capture and geological storage, fuel cells, language industries, logistics and supply chain, and oil sands.

The government has repeatedly stated its commitment to ensure that all Canadian communities have access to broadband networks, and the 2001 Budget earmarked $105 million for broadband expansion. Broadband is becoming increasingly important for economic development, as well as in enabling Canadian companies to build and deliver innovations in areas such as health care, education and e-commerce. Broadband access will provide a number of opportunities to First Nations, northern, rural and remote communities in a number of sectors that will, in turn, work towards the sustainability of these communities. On August 5, 2002, Industry Canada launched its Broadband for Rural and Northern Development Pilot Program to start to address these needs. A one-time, capital-cost-matching investment initiative, the

program will use a competitive process to support the deployment of innovative and sustainable broadband services to communities that currently have no high-speed Internet access.

Industry Canada is also committed to the development and application of eco-efficient tools, products and practices. Environmental technologies are important drivers of innovation and productivity growth, which also contribute to sustainable development, improved competitiveness and better environmental performance. The department's Web site provides information on the benefits of eco-efficiency for Canadian business, including industry practices, case studies, and links to other useful sites and eco-efficiency tools.

To ready itself for implementation of the Framework for Science and Technology Advice, Industry Canada recently underwent a capacity check of its ability to use S&T advice in policy and regulation development and decision making. Industry Canada will adopt measures to ensure consideration of S&T advice, where appropriate, and to raise awareness of the Framework throughout the Department.

The Minister of Industry has mandated responsibility for horizontal S&T policy coordination across the government. As a consequence, the Department plays a secretariat role to several advisory bodies that provide longer term, strategic advice on S&T. These include the Advisory Council on Science and Technology, the Council of Science and Technology Advisors and the Canadian Biotechnology Advisory Committee. Industry Canada, in partnership with Human Resources Development Canada, also hosted the National Summit on Innovation and Learning in November 2002.

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NATIONAL RESEARCH COUNCIL CANADA

The National Research Council Canada (NRC) is a leader in the development of an innovative, knowledge-based economy for Canada through S&T.

NRC operates 18 research institutes and a number of specialized technology centres across Canada. Its advances in R&D help build Canada's innovation and technology capacity, support the growth of Canadian industry, and help drive solutions for national challenges in health, climate change, the environment, clean energy and other fields.

NRC works with SMEs through its Industrial Research Assistance Program (NRC-IRAP), which is active in more than 90 communities across Canada. NRC also helps disseminate critical scientific, technical and medical information through the NRC Canada Institute for Scientific and Technical Information — Canada's largest science library.

Major Achievements

In 2001–02, NRC launched its Vision 2006, an integrated, five-prong national strategy designed to help build Canada's innovative knowledge-based economy through S&T. NRC has had substantial achievements relative to the Vision.

Stimulating Community-Based Innovation

Community-based "technology clusters" have attracted world recognition as key drivers of innovation and wealth creation. In Canada, community-based innovation is a key priority of the Government of Canada, highlighted both in its recent throne speeches and in its national *Innovation Strategy*. The NRC has an established track record in building successful clusters in cities such as Saskatoon, Ottawa and Montréal.

Communities benefit from the NRC's leading edge R&D and regional, national and international networks, which generate opportunities for the cluster both in Canada and around the world. NRC works in each community, helping it to define its strategy and action plan for growth, identify local champions, and bring together the key players needed to build and sustain the growth of its identified cluster sector.

In 2001–02, NRC worked in communities across Canada to support the growth of emerging technology clusters and to add new dimensions to the following maturing clusters:

- ocean and marine engineering technologies — St. John's;
- life sciences and marine biosciences — Halifax;
- e-business and wireless technologies — Fredericton, Moncton, Saint John and Sydney;
- aerospace, biopharmaceuticals and industrial materials — Montréal;

- aluminium technologies — Ville Saguenay;
- information technology, life sciences and photonics — Ottawa;
- medical technologies and devices — Winnipeg;
- agriculture biotechnology and nutraceuticals — Saskatoon;
- nanotechnologies — Edmonton;
- fuel cells — Vancouver; and
- astrophysics and astronomy — Victoria and Penticton.

Extending Canada's Global Reach

NRC provides Canada with strategic S&T information, intelligence and connections to global centres of advanced S&T. NRC has created significant international networks, helping transfer valuable S&T information and market opportunities to Canadian industry and organizations. NRC also represents Canada on dozens of international measurement standards committees, helping remove standards-based barriers to trade for Canadian industry. NRC also provides Canadian researchers with access to major international scientific facilities and opportunities.

During 2001–02, NRC was involved in some 359 research partnerships and collaborations, led more than 40 formal S&T missions to other countries, hosted dozens of incoming international S&T missions, and participated in 589 international committees and 646 international conferences. It signed new or renewed S&T Memorandums of Understanding (MOUs) with the United Kingdsom, Taiwan, Germany, Spain and France. Such agreements are critical to ensuring Canada's place in the global knowledge economy. For example, the renewal of a Canada–Taiwan MOU continued an agreement first signed in 1997 that has created 16 co-research projects and almost a dozen international patents for partners.

Creating Value for Canada

NRC is committed to stimulating innovation and wealth creation and has moved aggressively to ensure the efficient transfer of NRC-created knowledge and technology to the marketplace.

During 2001–02, NRC created three new spin-off companies, bringing the total since 1995 to 52. All but three of these firms are still active. NRC had more than 1200 private and public sector collaborations in Canada and internationally, including such major collaborations as a $10-million agreement with Dow Agro Sciences in agricultural biotechnology. These collaborations greatly extend the impact of NRC resources: for each dollar contributed by NRC, partners from the private sector, university and other public sector organizations contribute almost three dollars.

NRC also generated 65 new patents, and, in the past five years, almost 300 new patents have been issued to NRC. It has signed more than 50 new technology licences with Canadian industry, helping build a pool of 256 active licences. NRC also provided expert assistance, advice and services to more than 12 400 Canadian SMEs through NRC–IRAP. NRC also continued to stimulate the innovative capacity of industry through its network of Industry Partnership Facilities (IPFs). During the past fiscal year, 71 companies were incubating at existing NRC IPF facilities, which form an important part of NRC's innovation infrastructure. There are six more NRC IPFs under construction across the country and another four in the planning stages.

Excellence and Leadership in R&D

The creation of new knowledge is at the heart of NRC's contributions to Canada and Canadians. The NRC's research strengths are organized around key sectors, including aerospace, advanced manufacturing, biotechnology, information and communications technologies, and ocean engineering.

In the past year, NRC pushed forward into strategically important fields for Canada, including fuel cells, photonics, nanotechnology, and environmental and sustainable development technologies — areas key to the health, well being and economic prosperity of Canadians. Highlights in the past year included:

- A new, inexpensive, non-invasive and almost foolproof test for colon cancer that could prevent thousands of deaths through earlier detection of this disease.
- The development of a new type of nano-scale transistor based on "spintronics," a breakthrough that holds enormous potential for the creation of small, inexpensive and extremely powerful computing devices.
- Unique fire research, including a project that evaluated the response of smoke detectors and the performance of plastic sprinkler systems in the home. The lessons learned will help protect Canadians from fire for years to come.

- The launch of new R&D facilities including the $120-million National Institute of Nanotechnology in Edmonton, the Advanced Aluminium Technology Centre in Ville Saguenay, Hydrogen Safe Labs in Vancouver, a new e-business institute in Fredericton, and the Aerospace Manufacturing Technology Centre in Montréal.
- Continued involvement in national science projects and facilities including TRIUMF (the Tri-University Meson Facility) in British Columbia, the Sudbury Neutrino Observatory and the Canadian Light Source in Saskatoon.
- The publication of some 1009 articles in refereed journals, some 800 conference papers and some 1569 technical reports.

Outstanding People — Talent for Canada

NRC's success on behalf of Canada lies with its nearly 4000 knowledgeable, creative and talented staff. In 2000–01, NRC launched its Employment Philosophy: its commitment to being an outstanding employer of outstanding people.

NRC also engaged more than 1200 guest workers from Canadian and foreign universities, companies and public sector organizations. Their work not only helped NRC, but their home organizations gained equally from the training they received and the transfer of knowledge and know-how from NRC.

NRC also contributed to meeting the national demand for a well-educated and skilled work force for Canada. In the past year, 222 postdoctoral fellows participated in NRC student programs, valuable training in preparation for future positions in universities, industry, etc. NRC continued to build its work force with an aggressive recruitment campaign to attract leading scientists and engineers from many different fields. NRC also contributed through training activities and through its support of programs by other government agencies and universities — in Canada and internationally.

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NATURAL RESOURCES CANADA

Over the last three years, Natural Resources Canada (NRCan) has reoriented its policies and S&T programs to promote the sustainable development and use of natural resources: the integration of economic, social and environmental objectives in decisions to develop and use energy, minerals and metals, and forests.

NRCan's Earth Sciences Sector provides the geoscience and geomatics knowledge and expertise Canadians need to understand Canada's landmass and to support public policy decisions. It also provides support for scientific research in the Canadian Arctic. The Canadian Forest Service promotes the sustainable development of Canada's forests, the competitiveness of the forest industry, and provides knowledge that contributes to sound decision making about the future of forests and forestry at national and international levels. The Minerals and Metals Sector encourages the sustainable development of Canada's mining industry, provides policy advice, and commodity and statistical information. It is also the Government of Canada's primary source of expertise on explosives regulations and mining, minerals and metals technology. The Energy Sector develops and delivers policy advice and knowledge- and technology-based solutions for the sustainable production and use of Canada's energy supply.

Major S&T Achievements in 2002

Innovative and Strategic Partnerships

NRCan continues to develop synergies with universities, industry and non-government organizations (NGOs) by entering into alternative S&T delivery partnerships, to enhance the delivery of its S&T. For example:

- Innovative partnerships between NRCan and several universities with funding through the CFI will involve co-locating specialist staff from NRCan at the universities to operate new analytical facilities. These partnerships will also result in the creation of new natural resources research centers, for example an Oil Sands Tailings Research Centre in Alberta. Comparable partnerships will result in locating new equipment for university research at NRCan specialized facilities, such as the Explosives Research Laboratory in Ottawa, and access to off-campus nationally unique facilities at NRCan for university research.

- Mathematical and algorithmic tools developed for precise three-dimensional mapping of high-resolution IKONOS and QuickBird satellite images were commercialized under an NRCan licence by PCI Geomatics, which has sold 1000 licences worldwide.
- NRCan's Innovation Acceleration Centre (IAC) develops geomatics products and services by transferring technology and providing easy access to technical expertise and information. Eleven companies are currently working with the IAC, in projects such as combining satellite and/or airborne-based imagery with more traditional data to map mineral deposits.
- The formation of a deep mining consortium worth $15–20 million over five years, between NRCan, the Ontario government and the mining industry, is one example of an extensive long-term federal-provincial industrial partnership.

Excellence in Policy-Linked Science Advice

One of the key roles of federal S&T is to provide balanced advice as input to the development of regulations and policy. NRCan has taken an integrated approach to ensure that decisions and policies are based on sound advice and analysis of economic and scientific input. Because of the large economic impact of the minerals and metals cycle, especially in automotive manufacturing, NRCan has taken steps to improve internal coordination between science and policy during early stages of the cycle, and S&T input that involves all stages of the cycle. Closer collaboration with Industry Canada has been achieved through joint management meetings and through NRCan's participation in Industry Canada foreign delegations to China and Europe. NRCan also provides input via industrial advisory boards and industry associations to facilitate a transfer of S&T knowledge and capabilities to industry.

NRCan plays a major role in the uniform data collection required for the monitoring and reporting of mercury emissions from the electrical power generation sector as a basis for establishing the emission limits to be regulated under the *Canadian Environmental Protection Act*. New emission standards for mercury emissions will have significant ramifications on stationary and non-stationary emission sources.

Excellence in Science Information

NRCan conducts leading-edge S&T on Canada's land and resources, and builds and maintains a national knowledge infrastructure. The following items highlight this year's exceptional achievements in NRCan science information.

Information on Canada's forests is abundant, but difficult to gather and compile because it is produced and collected by federal and provincial governments, First Nations, industry and NGOs. In cooperation with provincial and territorial partners and Canada's GeoConnections, NRCan has implemented a Web-based framework called the National Forest Information System (NFIS) to access and report information from all these sources. NFIS is designed to provide accurate and timely information for Canada to report on both domestic and international commitments such as carbon accounting.

NRCan supports the R&D of more energy efficient window technologies. Windows can account for about 30 percent of the annual heat loss in typical homes. Based on its expertise in this area, NRCan provided key technology information to assist in the development of a window energy rating system, Energy Star, which is now part of the Canadian Standards Association standard for windows.

The $36-million Mallik Gas Hydrate Research Production Well Program provided geoscientific support for the sustainable development of northern resources in the Mackenzie Delta. The program investigates the production potential and economic viability of gas hydrates, and their potential role in climate change and as a natural hazard. Gas hydrates may be a new energy source that is a cleaner-burning alternative to conventional hydrocarbons.

The Fisheries and Oceans Canada vessel *Nahidik* was used in the Beaufort Shelf area to carry out geohazards research on the ocean floor. This information is needed for the evaluation and recommendation of proposed pipeline corridors for northern natural gas.

The NRCan Explosives Research Laboratory produced S&T information to assist the Explosives Regulatory Division, whose mandate regarding the import/export, transport and storage of explosives has increased since the events of September 11, 2001.

Climate Change

The Government of Canada released the Climate Change Plan for Canada on November 21, 2002. NRCan plays a critical role in addressing the challenge of climate change by virtue of its mandate for the sustainable development of Canada's natural resources. The Minister of Natural Resources leads the

Government of Canada in implementing Canada's domestic response to climate change. NRCan's S&T leadership in the International Energy Agency Greenhouse Gas Program has led to significant advances in the science of CO_2 capture and storage. In 2002, S&T advice arising from this program resulted in the adoption of CO_2 Capture and Storage as one of the major response strategies in Canada's Climate Change Action Plan.

NRCan is a partner in Fluxnet–Canada, a research network project that will add to our current understanding of how carbon cycles through Canada's forests and peat land, relative to climate change. Multiyear measurements and modelling provide an opportunity to manage the Canadian biosphere for sustainable reductions in greenhouse gases.

An expedition to Mt. Logan collected a continuous 173-metre ice core from snowfields that have accumulated over 10 000 years. The analysis will provide continuous information on the climate record in Canada's northwest over that time and help to address a broad range of climate change issues. Additionally, Canada-wide inventories and maps, such as national-scale water coverage and land-cover change mapping, were compiled in support of climate change studies.

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NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA

The Natural Sciences and Engineering Research Council of Canada (NSERC) is the primary federal agency investing in university research and training in the natural sciences and engineering (NSE). Annually, NSERC invests more than $680 million in people, discovery and innovation at Canadian universities and colleges. These investments build Canada's capabilities in S&T and support innovation that drives the economy and improves the quality of life of all Canadians.

The Government of Canada has set a new goal for Canada — moving to among the top five Organisation for Economic Co-operation and Development (OECD) countries in R&D investment per capita by 2010. This ambitious benchmark underscores the government's *Innovation Strategy*, of which NSERC is an integral part. Canada's innovation system benefits directly from NSERC's support for the creation of new knowledge through basic university research. Our innovation system also benefits from the dissemination and commercialization of this new knowledge in Canada through NSERC-supported partnerships among universities, colleges, governments and the private sector. Through all of these activities, NSERC supports the advanced training of highly qualified people (HQP).

This review highlights NSERC's achievements in fulfilling its mandate for 2001–2002.

Major achievements in 2001–2002

Investing in HQP for Today and Tomorrow

Canadians, equipped with the skills and knowledge required to create value, will enable Canada to be competitive in the global knowledge economy. Canada's future capabilities in S&T depend on today's graduate students and new faculty. Students and postdoctoral fellows trained with NSERC funding have the skills required to pursue rewarding careers across all sectors of the economy.

NSERC's investments help satisfy Canada's demand for highly skilled people in many knowledge-intensive sectors. Over the last decade, graduates in the NSE have experienced far less unemployment (1.7 percent) than the norm in Canada (8 percent). Since 1978, NSERC has helped more than 58 000 students complete an advanced degree.

NSERC invests in the advanced training of HQP in two ways. It provides scholarships and fellowships to selected individuals through national competitions. It also supports students through research grants awarded to professors. A professor may hire a student or postdoctoral fellow with funds from an NSERC grant. On average, 40 percent of the grant money awarded to professors is spent on the training of HQP.

Annually, NSERC supports approximately 19 000 students, postdoctoral fellows, technicians and research associates. In 2001–02, NSERC created an additional 200 NSERC Postgraduate Scholarships and 300 additional Undergraduate Student Research Awards (USRA).

The USRA program provides four months of work experience in a university or industry laboratory for undergraduate students in a science or engineering discipline. Of the nearly 3500 students who take part in the program every year, 82 percent plan to pursue graduate studies.

Through its university–industry partnerships programs, NSERC exposes students to the opportunities available in Canadian industry and provides industry with direct access to talented students coming out of our universities. These programs help train talented youth in areas of science and engineering that are relevant to Canadian industry and, therefore, they help to retain HQP in Canada after graduation.

NSERC promotes science to build a broad-based appreciation of the contributions of science. Through the media, NSERC actively supports the popularization of new knowledge in the NSE. For example, in an average month in 2001–02, NSERC-related newspaper articles reached almost four million readers. NSERC also promotes science by helping to identify the NSE disciplines as good career choices for youth. PromoScience, a program of grants to not-for-profit organizations that help Canadian youth learn about opportunities in the NSE, received additional funding in 2001–02. Through PromoScience, NSERC aims to recruit the next generation of scientists and engineers.

Funding the Discovery Process

NSERC investments give Canadian professors the opportunity to contribute to and to access the latest international research, to extend the boundaries of our knowledge in all areas of the NSE. More than 9000 professors were funded in 2001–02 through NSERC Discovery Grants and other research grants.

Basic research driven by a professor's curiosity often generates innovation. For example, Dr. Raymond Andersen, an NSERC-funded professor in the Department of Chemistry at the University of British Columbia, uses marine life to produce new drug innovations. Technology created from his research on aquatic sponges has resulted in licensing agreements that will enable the development of a natural asthma treatment and a novel antibiotic.

NSERC-funded research has led directly or indirectly to the creation of new value-added products, processes and industries in Canada. For example, NSERC has identified 134 first-generation spin-off companies arising out of NSERC-funded research. In 2001–02, these companies employed more than 12 000 Canadians and generated more than $2.4 billion in annual sales. Investments in knowledge creation also help determine policy, standards and regulations, for example, for the protection of the environment.

NSERC is seeing a sustained increase in new applicants for Discovery Grants, who are establishing their research careers as faculty in Canada's universities. These new professors, who are expected to be active in research, are critical to Canada's future capabilities in S&T: they generate knowledge and innovations and also train HQP. Supporting them is NSERC's first priority. In the past two years, NSERC directed $27.5 million toward new applicants out of a $36.5-million increase to the Council's annual budget.

Canadian researchers in all sectors of the NSE publish roughly 17 000 journal articles per year, placing Canada sixth overall in the world in the total number of articles published. They are very productive, publishing more than 4 percent of the world's scientific papers for less than 3 percent of the world's investment in research.

Helping Canada to Innovate

For industries to improve their competitive positions, they need to take full advantage of Canada's capacity for science-based innovation. NSERC's Research Partnerships Programs facilitate the development and exchange of knowledge, technology and people across all sectors to help build an innovative economy. Through NSERC investments, university researchers connect with those who can use new knowledge productively and enhance Canada's capacity for innovation. This in turn contributes to wealth creation that benefits all Canadians.

NSERC continues to offer a flexible mix of programs in support of innovation. These cover a broad spectrum of activities that include:

- targeted research;
- research clusters;
- joint university–industry projects;
- technology transfer;
- industrial research chairs; and
- capacity building for the management of intellectual property.

In 2001–02, NSERC's Intellectual Property Management Program was expanded to include a Networked Training initiative, in collaboration with the Canadian Institutes of Health Research (CIHR) and the Social Sciences and

Humanities Research Council of Canada (SSHRC). This initiative aims to help develop technology transfer and commercialization practitioners who are in short supply. We must increase the pool of trained technology transfer personnel with hands-on experience available to Canadian universities and hospitals if these institutions are to succeed in maximizing the benefits to Canada of our publicly funded research.

In 2002, another important development to foster innovation has been the expansion of the Technology Partnerships Program to include the proof-of-concept stage of the R&D process.

For every dollar NSERC invests in its university–industry partnerships programs, another $1.84 is levered from partners. Since the program's inception, industrial partners have invested more than $750 million in university-based research and training activities. Current activity supported by NSERC's Research Partnerships Programs involves 689 ongoing projects, with 817 industry and government partners.

The Networks of Centres of Excellence (NCE) is a unique Government of Canada partnership program administered jointly through NSERC, CIHR and SSHRC in partnership with Industry Canada. NCEs are innovative research partnerships among universities, the private sector and governments that address complex problems of critical importance to Canadians. In an average year, the 22 existing networks will involve 5000 participants, create 17 spin-off companies, and assist 1500 university graduates to obtain employment in industry.

Supporting *Canada's Innovation Strategy*

Placing Canada among the top five nations in R&D investment per capita will require many HQP trained at Canadian universities and colleges. In this context, NSERC set a planning target of doubling the graduation rates of people with advanced degrees in the NSE. To learn how it could help universities to achieve such a goal, NSERC sponsored five workshops on HQP across Canada in the spring of 2002. The final report from these workshops can be found at **www.nserc.ca/about/hqp.htm.**

The findings and proposals collected through the workshops are a starting point from which to develop an action plan and future strategy on how NSERC will help address the HQP challenge associated with *Canada's Innovation Strategy.*

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PARKS CANADA

Parks Canada's mandate is to protect and present nationally significant examples of Canada's natural and cultural heritage on behalf of Canadians. Parks Canada manages three major programs: national parks, national historic sites and national marine conservation areas.

Science Advice

Ecological integrity and commemorative integrity are the key management goals for the agency, enshrined in law and policy. To ensure the protection, maintenance and restoration of ecological and commemorative integrity, Parks Canada is developing its science capacity for all its program areas. Building on larger government-wide initiatives,[2] in 2002, Parks Canada developed a Science Strategy to ensure the presence of science advice at the management table. The Science Strategy also identifies objectives and results for the next five to ten years and outlines priority activities for the next one to five years.

Science in National Parks

National parks act as long-term ecological research sites, serving as ecological benchmarks for the study of natural environments and their components in a relatively undisturbed state. Park-based research is not only of value in assisting park management and interpretation, but contributes to the growing body of scientific knowledge concerning our natural world. Scientific studies in parks are seen as increasingly important because they can help reveal changes occurring in ecosystems as a result of human intervention or nature. Over the last year, a range of studies has been carried out in Canada's national parks. Here are some highlights:

2. See the Council of Science and Technology Advisors' *SAGE* and *BEST* reports.

Park Planning — Determinating the Best Ecological Boundaries for Establishing and Managing Canadian National Parks

Planning is under way for a proposed national park in the Interlake area of Manitoba. To assist in establishing a park with a size and configuration that takes into account a broad range of ecological considerations, a geographic-based analytical approach was used. The approach queries ecological data bases to determine the following:

- an adequate representation of terrestrial and aquatic ecological targets at regional, coarse and local scales, (i.e. representation in terms of both the occurrence and spatial distribution of biological and physiographic features); and
- the maintenance of ecological and evolutionary processes.

This project aims to develop new approaches based on landscape ecology principles to define ecological boundaries for protected areas.

Traditional Ecological Knowledge and the Management of Natural Resources — Case Studies from Northern Canada

A project was launched in 2002 to explore how the commitment of Aboriginal groups, academics, government and NGOs to use or integrate traditional ecological knowledge (TEK) into decision making is affecting resource management. Using four to five case studies, this project will document the way in which Aboriginal systems of management and knowledge are shaping management structures. The use of TEK terminology, concepts and procedures in the decision-making process will also be addressed.

The Use of Science and Clam Management in Kouchibouguac National Park

Since 1981, the local population around Kouchibouguac National Park, New Brunswick, has been allowed to practise traditional activities such as commercial fishing and soft-shelled-clam (*Mya arenaria)* harvesting in the park. Before 1993, no effective management system was in place to ensure the long-term viability of the clam population under harvesting pressure. Clam population surveys conducted in 1993, 1994 and 1996 showed an over-harvesting of the resource. Following those results, clam harvesting was banned for a two-year period from 1997 to 1999, resulting in income loss for local harvesters. A new monitoring program collects data on clam beds during the surveys and also takes into consideration the traditional knowledge of local harvesters. Data are analyzed and mapped with a Geographic Information System (GIS), allowing the representation of clam beds with densities and age-class distribution. For the first time, managers have access to a spatial representation of clam beds. This method allows managers to implement rotation-type harvesting by predicting not only the beds ready for harvesting, but also the recruitment level of each bed and, therefore, the year it could be open to harvest.

Advanced Very High Radiometric Resolution Monitoring

In 2001–02, a project was launched to use large-scale satellite images to accomplish three monitoring goals: quantify plant community fragmentation, measure the interval in which ice disappears from large lakes, and identify sites of early vegetation green-up in the largely inaccessible northern parks. Meeting all of these goals will help us understand the roles of large-scale disturbance and global warming on the ecological integrity of the national parks network.

Monitoring the Population Status of Peary Caribou on Ellesmere Island — Factors Affecting the Current Population Level

Over the past four decades, the Peary caribou (*Rangifer tarandus pearyi*) populations of the Queen Elizabeth Islands have suffered declines of more than 90 percent. The most recent drastic declines have been documented for Bathurst Island between 1994 and 1997, and the apparent cause of the decline has been attributed to severe winter and spring weather. An interdisciplinary project was launched in 2001–02 to document Peary caribou population size and distribution in northern Ellesmere Island, based on historic and current data. The project aims to identify critical habitat/areas for Peary caribou using Advanced Very High Radiometric Resolution satellite images (plant productivity indices). In parallel, the extent of population reduction will be assessed by genetic analysis (population bottlenecks).

Ecosystem Management, Coastal British Columbia Paleoecology — Land–Sea Interactions

A new research program was undertaken in 2001 to use paleoecological techniques to develop an understanding of the environmental factors governing ecosystem structure and the interplay among terrestrial, freshwater–aquatic and

marine systems since the last continental glaciation. Emphasis is on understanding the structure and function of ecosystems prior to European settlement on the west coast of Canada, and how they apply to ecological integrity, biological conservation and climate change. Changes in vegetation, aquatic organisms and salmonid presence are examined using radiometrically dated sediment cores along the west coast of Canada. The results are then used as a measure of ecological integrity for Canada's protected areas.

National Historic Sites

Technological Applications to Cultural Resources Management

Geomatic applications such as GIS and global positioning systems are used to do predictive modelling of archaeological resources and to keep site-location data bases updated in western national parks. They are also used to do distributional analysis and to develop monitoring programs in many land and underwater national historic sites in Manitoba, New Brunswick, Nunavut, Quebec and Ontario.

Geophysical surveys instrumentation (e.g. sonars, resistivity meters) are used to locate buried archaeological features or unmarked grave sites and, in some cases, to monitor the stability of the natural environment containing cultural resources. This type of work has been performed in national historic sites in Alberta, Nova Scotia, Quebec and Saskatchewan, in Prince Edward Island National Park, and in western national parks.

Science Advance for Cultural Resources Knowledge

Multidisciplinary analysis of archaeological specimens is conducted to enhance knowledge of human and natural history of national parks and national historic sites. Many of these analyses are done in cooperation with universities. Good examples are the forensic or micro analysis of diverse animal, human, plant and mineral samples (e.g. bones, seeds, ceramics, lithics, pollens, soils, carbon dating) from national historic sites and national parks in Nova Scotia, Newfoundland and Labrador and Prince Edward Island, as well as in western and northern parks. Also, diverse research projects on paleontological and archaeological sites associated with marine transgression are taking place in Gwaii Haanas National Park Reserve.

Partnerships have been established with Public Works and Government Services Canada to research ways to extend the life of historic building materials, ranging from Haïda Mortuary poles to mortar to historic timber structures and frames.

Historical and archaeological studies and analyses are conducted to enhance the representativeness of the system of national historic sites for the Historic Sites and Monuments Board of Canada.

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PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Public Works and Government Services Canada (PWGSC) plays a key role in the implementation of almost every aspect of the Government of Canada's agenda by contributing directly to the advancement of key government priorities. The PWGSC's S&T activities are thus directed at meeting the challenges and opportunities posed by the Speech from the Throne. More specifically, these S&T activities focus on the areas of climate change and environment, sustainable development, healthy communities, smart regulations, R&D leading to innovation, and enhancement to quality of life for Canadians through the provision of real property leadership and stewardship in the Government of Canada.

While many varied S&T activities are being carried out within the department, this report provides a sampling of the S&T activities undertaken by the Technology Directorate of the Real Property Program Branch (RPPB). The Technology Directorate researches, develops, demonstrates, promotes and transfers leading-edge technologies related to the design, construction, maintenance, use and operation of the real property assets managed by the Department. These assets are numerous and varied. They include office buildings, heritage buildings such as the Parliament complex, special government laboratories, bridges, highways and dams. The applied research program is carried out in collaboration with the private sector, universities, other government departments, and other national and international research organizations through recognizing each other's expertise and leveraging resources to achieve results in a timely and cost-effective manner.

The following provides highlights of S&T activities related to the applied research program priorities in the RPPB.

Energy Conservation and Environment

Research projects to save energy in buildings and reduce greenhouse gas emissions and other environmental impacts in support of government initiatives include:

- air leakage control in buildings;
- energy efficiency of building assemblies;
- energy efficiency through building recommissioning;
- underground thermal-energy-storage systems; and
- on-site power generation technology in office buildings.

Improving the Workplace Environment

Research to achieve a supportive workplace environment explores appropriate lighting and heating and cooling levels, managed noise, a sense of daylight and good air quality. Examples include:

- personal environmental controls and their integration with wireless technology;
- reduced emissions from building materials and furnishings;
- energy-efficient lighting systems;
- improved open-office acoustics;
- building connectivity through local-area and wireless networks; and
- optimized daylighting in office buildings.

Facility Life-Cycle Management

Initiatives focus on extending the useful life of buildings by increasing the integrity of their components and systems through research and the implementation of new technologies. For example:

- developing corrosion-resistant alloy steels;
- controlling humidity in exterior envelopes of heritage buildings;
- implementing performance monitoring and self-diagnostic technologies to safeguard infrastructure integrity;
- implementing reliability-based life-cycle quality-management systems; and
- developing life-cycle assessment strategies.

Asset Management Tools

As the custodian of the Government of Canada's office space inventory, the PWGSC is Canada's largest landlord. The development of tools and practices is undertaken to simplify real property management and the stewardship process, and to make the operation of buildings more cost-effective. Examples of asset management tools used by the PWGSC include:

- spatial information management software;
- intelligent building automation systems;
- Tech2 space management software (specific to PWGSC);
- fault-detection and diagnostic technology;
- a computer-aided facilities management system;
- a fire-risk-evaluation and cost-assessment model; and
- infrastructure security measures.

Developing Standards and Best Practices

PWGSC is also involved in the development of standards and best practices in the building industry that serve as "maps" for better construction methods and for higher-quality end-products. Examples include:

- the National Master Specification for construction documents;
- participation in committees related to real property under the auspices of international bodies such as the International Organization for Standardization (ISO), the International Energy Agency, the International Association for Building Materials and Structures (RILEM — Réunion Internationale des Laboratoires d'Essais et de recherche sur les Matériaux et les Constructions), and the International Council for Research and Innovation in Building and Construction;
- the CSA standard for the recycling of construction waste and seismic risk reduction; and
- international standards for the use of non-traditional materials in construction.

Sharing and Transfering Research Results and Innovations

New knowledge only becomes valuable when it is applied. A variety of communication tools and activities are employed to make innovations and research results available to interested users beyond RPPB. Examples include:

- sharing research information with the provinces, the research community and industry through such bodies as the Building Technology Transfer Forum and the Technology Transfer Task Force;
- showcasing innovations to the real property community and to the design and construction industry in real projects; and
- organizing and delivering seminars, workshops and training sessions.

Innovative Research

Adapting existing technology to unique building applications is another means by which the Department aligns itself with the objectives of the federal S&T strategy. Examples of this technology include:

- infrared thermography to detect mould and fungus in walls;
- 3-D simulation technology for the demonstration of infrastructure security, sustainability and safety; and
- a sophisticated system to monitor the structural integrity of the Confederation Bridge, Prince Edward Island.

National Scientific Program

The Technology Directorate works closely with NSERC on joint research programs such as the monitoring of the Confederation Bridge. Also, the Directorate participates in reviewing grant applications related to the building industry with NSERC, the Canada Foundation for Innovation and other government organizations under the Program of Energy Research and Development.

Strategic Role and Partnerships

Examples of strategic partnerships include the following:

- The Department established the Technology Transfer Task Force Committee for sharing information, transfering innovations and developing strategic alliances in research projects related to real property assets. The Committee includes representatives from all major Canadian universities and from key industry associations with an interest in construction, buildings and real estate.
- The Department is an active member of several other government-industry-university working groups and transfer forums such as the Advanced Building Systems Integration Consortium and the Research Protocol Development Committee of the General Services Administration in the United States.
- Internationally, PWGSC conducts and participates in joint workshops with overseas real property research centres, universities and real property organizations. MOUs have been signed for a variety of research projects with the Japanese Building Research Institute; the National Center for Research in Earthquake Engineering, Taiwan; and the California Department of Transportation.
- RPPB plays an active role in Canadian S&T policy through membership in several policy-setting committees, including the Expert Panel on Canada's Role in International Science and Technology.
- Within Canada, the Canadian Standards Association has used the research findings of the Directorate as a foundation for the development of national standards related to buildings and construction.

In summary, despite the abundant use of S&T in the construction sector, there is no recognized leadership to promote this sector's activities in the government's agenda of innovation, sustainable development and quality of life for Canadians. RPPB, through the efforts of its Assistant Deputy Minister, has been participating in the National Steering Committee on Innovation in Construction. This private sector-led initiative, in conjunction with the government agenda, aims to establish a permanent focus for the Canadian construction industry to support innovation and increase the competitiveness of Canadian companies in the global marketplace.

The PWGSC, in its move to become a world-class organization, participates in the Interdepartmental Network on International Science and Technology, chaired by DFAIT. Federal S&T counsellors, in missions abroad, remain the conduit for information to promote Canadian expertise and facilitate contacts with foreign governments and industry in the

field of innovative technologies, construction materials and other aspects of real property management.

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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 and humanities. The Council also charts directions for the Canadian research effort in these fields. SSHRC funds research in more than 30 disciplines, ranging from business, economics, education, environmental studies, ethics, history and law to literature, management studies, philosophy, psychology, religious studies, and sociology. It supports basic, investigator-driven research, the training of highly qualified personnel, targeted research on issues of national importance, and the broad dissemination of research-based knowledge for the benefit of Canadians. Finally, SSHRC also pursues important initiatives closely aligned with the objectives of the federal S&T strategy.

SSHRC invested $53.3 million in basic research grants programs in 2001–02, and $29.5 million in research training. In 2002, the Council supported about 2000 basic research projects, more than 1460 doctoral students and more than 230 postdoctoral fellows.

Addressing Knowledge Gaps and Building Partnerships

SSHRC is continuously developing new programs and initiatives to enhance research and promote innovation and partnerships with users of research. An important objective is to support multidisciplinary research in key socio-economic and cultural policy areas to provide sound evidence and data for public policy development. Specifically, SSHRC designs strategic programs to fill knowledge gaps and sets up joint initiatives with government departments, agencies and other partners to connect producers of knowledge with knowledge users.

Initiative on the New Economy

A five-year, $100-million program launched in 2001, the Initiative on the New Economy (INE) supports research that helps to keep Canada at the forefront of the knowledge economy. This program explores the challenges and opportunities of the new economy in four major research areas:

- the nature of the new economy;
- management and entrepreneurship;
- education; and
- lifelong learning.

The new knowledge generated by INE-supported research enables decision makers in the public, private and not-for-profit sectors to devise new policies and practices that enhance Canadians' success in the new economy. In particular, INE-funded research is providing Canadians with a better understanding on key issues such as:

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

Demand for research in INE-targeted fields is high. Since June 2001, researchers submitted 471 applications to the INE, 122 of which were approved, resulting in funding commitments of more than $40 million over the next few years.

Community University Research Alliances

In 1999–2000, SSHRC launched the Community University Research Alliances (CURA) pilot program — an innovative model to develop knowledge and expertise for community development through broad research alliances between universities and local/regional groups. In March 2002, the Council decided to instate CURA as a mainstream program starting with 2002–03 competitions. Thus far, 37 CURAs have been established, representing an investment of more than $22 million.

CURAs focus on issues such as evaluating social strategic planning in Newfoundland and Labrador, 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 Prairies.

Targeted Research for Socio-Economic Development

In March 2002, SSHRC selected four priority areas that will govern the direction and form of new strategic programs over the next five years:

- Aboriginal Research;
- Environment and Sustainability;
- Culture, Citizenship and Identities (including Democracy, Culture and Citizenry, and Peace and Security); and
- Image, Text, Sounds and Technology.

In 2002, SSHRC, Environment Canada, and the National Roundtable on the Environment and the Economy conducted broad stakeholder consultations on the need for more knowledge about the social, economic, legal and cultural aspects of the environmental issues facing Canadians. SSHRC will apply the outcome of these consultations to its design of a major new initiative to mobilize research on the environment and sustainability.

SSHRC also developed three new joint initiatives with public and private sector partners in 2002:

- Network on the Human Dimensions of Biosphere Greenhouse Gas Management (with the BIOCAP Canada Foundation) — a collaboration designed to boost research and expertise on the socio-economic factors relating to practices and uses of technologies in greenhouse gas management.
- Health Disparities (with the CIHR) — a joint initiative aimed at increasing research expertise in the areas of health disparities and vulnerable populations.
- Fellowship Supplements for Research on Canadian Children and Youth (with Human Resources Development Canada) — a program enhancing Canadian doctoral and postdoctoral research capacity on policy-relevant issues relating to children and youth.

Since 1989, SSHRC has launched 39 joint initiatives, which thus far generated more than $57 million in additional funding "levered" from partners for social sciences and humanities research.

Supporting Excellence and Building Research Capacity

SSHRC is the federal agency that administers the $900-million Canada Research Chairs program for the three federal granting agencies. Established as a result of the 2000 federal budget, this program will support the creation of 2000 research chairs in all fields of research at Canadian universities by 2005. These chairs enable Canadian universities, together with their affiliated research institutes and hospitals, to achieve the highest levels of research excellence, and to become world-class research centres in a global, knowledge-based economy.

In 2001–02, 344 new Canada Research Chairs were awarded under the Canada Research Chairs program, for a cumulative investment of $359.4 million. The program is now more than a quarter of the way to meeting its goal of 2000 Chairs, with 532 Chairs awarded as of March 31, 2002. Sixty of these Chair holders represent a "brain gain" for Canada, as these researchers have come either from the United States or overseas, or have returned to pursue their careers in Canada.

In 2002, SSHRC oversaw the preparation of a performance and evaluation framework for this program, and conducted a mid-term progress review. The framework and the results of the mid-term review were made available to the public.

Moving Forward

Through its granting programs and activities, SSHRC will continue to support the production of knowledge and skills that sustain innovation, competitiveness and quality of life. SSHRC will develop new initiatives, enhancing strategic training opportunities for youth, promoting research on key socio-economic areas, and reinforcing Canada's research and training base. Finally, the Council will expand its partnerships,

reinforcing its knowledge-brokering capabilities to make available as widely as possible the results of SSHRC-funded research.

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STATISTICS CANADA

In Canada, the provision of statistics to all levels of government and to the public is a federal responsibility. By means of the *Statistics Act*, Parliament has designated Statistics Canada as the central agency responsible for producing and coordinating such information with the provinces and territories.

Agency data are used in support of statutes and regulations. These uses include:

- the distribution of federal funds to provinces (*Federal/Provincial Fiscal Arrangements Act*), including the apportioning of federal–provincial collections (Harmonized Sales Tax);
- indexing both federal payments to beneficiaries and income tax credits (*Income Tax Act*);
- determining eligibility for supplementary benefits (*Employment Insurance Act*);
- determining the distribution of parliamentary seats among provinces and defining federal electoral districts (*Electoral Boundaries Readjustment Act*);
- designating federal bilingual service areas (*Official Languages Act*); and
- measuring the prevalence of subpopulations that are the focus of the federal employment equity program (*Employment Equity Act*).

Historically, Statistics Canada's program has been structured to provide information on the macro-economy, the micro-economy and the socio-demographic structure of Canada. Statistical information is also provided on the nation's public institutions and programs. This constitutes the Agency's core program, which continues to be relevant. However, with issues continually emerging, the Agency must be ready and able to respond to evolving requirements for new information, the complexity of which is ever increasing.

Among the areas requiring more information and analysis to assist public and private decision makers in understanding the issues they face are the following:

- the new federal–provincial fiscal arrangements;
- the health of Canadians and the systems that support it;
- the factors affecting economic performance in the new knowledge-based economy;
- skills and learning;
- economic growth;
- the micro-economic factors affecting competitiveness;
- social cohesion;
- social capital;
- global opportunities and challenges; and
- the outcomes of social programs.

Maintaining the relevance of the Statistics Canada program by meeting such information needs and maintaining the integrity of the core program continue to be the primary goals for the Agency.

To accomplish these goals, Statistics Canada relies on the following two pivotal instruments:

- the advice and guidance it receives from external consultative bodies; and
- the Agency's planning and performance monitoring system and processes.

Science Advice

The external consultative bodies are the National Statistics Council, 14 professional and scientific advisory committees (including the Advisory Committee on Science and Technology Statistics), bilateral relationships with key Government of Canada 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.

Planning and Performance Monitoring

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:

- the 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]
- the 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;
- the 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; and
- the employees on whom the Agency depends, and the agencies charged with human resource (HR) management standards in government, who have an interest in performance in HR management.

Each of these stakeholder groups is addressed in regular reports to Statistics Canada's internal management committees.

There are six aspects of information quality that are pertinent to the use of information: relevance, accuracy, timeliness, accessibility, interpretability, and coherence. Some of these aspects can be quantified in numerical indicators, 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 Government of Canada, 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 the R&D activities, invention, innovation, technology diffusion and related HR 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* (Cat. No. 88-522-XIE). 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 Agency's work. The funding for this strategic development for 1999 to 2003 is part of a $20-million-a-year package, coordinated by the federal Policy Research Initiative, to reduce gaps in the statistical system.

The surveys of federal science activities provide information on what the government spends on S&T, where it spends its S&T resources (sectors and regions), and on what its resources are spent (socio-economic objectives). Longer-term objectives of this and the rest of the S&T statistics program are to demonstrate what the government gets for its S&T spending. Working papers and research documents are available free of charge on the Statistics Canada Web site.

Recent releases highlight the nature of innovative manufacturing firms, the characteristics of biotechnology firms and the commercialization of research. Selected research is summarized in the *Innovation Analysis Bulletin* (Cat. No. 88-003-XIE), available free of charge on Statistics Canada's Web site, as are all related working paper series and questionnaires.

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TRANSPORT CANADA

Transport Canada (TC) is actively involved in transportation S&T and R&D, and through its Transportation Development Centre, it manages a multimodal R&D program that focusses on improving safety, security, energy efficiency and accessibility. This work is augmented and complemented by specific R&D conducted by the Department's modal groups.

3. 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.

Highlights of Research Achievements

Security

Terrorism events have forced great changes in the transportation sector and focussed attention on the critical role of research in air safety and security. Working closely with U.S. security authorities, advanced, reliable and efficient technologies for the detection and containment of explosives and other threats, integrated security systems and human-machine interfaces continue to be developed on a priority basis.

Air Safety

Work is under way to promote the use of flight data monitoring programs.

In the field of aircraft de-icing, current projects include the Joint Runway Friction Measurement Program, the de-icing/anti-icing fluid guideline review, and contaminated aircraft and runway testing and analysis.

Long-term research on locator beacons is exploring Global Positioning Systems (GPS) technology as a potential replacement for ground-based navigational aids. GPS satellite navigation systems were tested, and results will be used in the development of an implementation plan.

R&D in aircraft cabin and fire safety has produced the Accident Database (ADB) and Confidence Level Tool. The ADB is now being used in three major safety programs.

Marine Safety

Distribution of the recently developed ice navigation simulator has been arranged, and a pilot course delivered. The simulator is Canada's contribution to an international effort to improve ice navigation training and standardize shipping rules in polar waters.

Marine emissions tests were conducted with diesel fuel emulsions and a continuous water injection (CWI) system. Earlier studies indicated that the CWI system offered the most cost-effective method of reducing diesel nitrogen oxide emissions at a low cost and with no appreciable fuel penalty.

A computer navigation tool designed to assist in maximizing a ship's draft in the St. Lawrence Seaway has been developed, and mathematical models are now ready to be integrated.

Features have been added to the ship evacuation simulation program, Marine Exodus, to allow simulation of the abandonment phase of evacuation.

Road Safety

A vehicle equipped with adaptive cruise control and a lane departure warning system was used to conduct an on-road study of driver behavioural adaptation in in-vehicle intelligent transportation systems.

Static and dynamic tests of side-mounted airbags in several different vehicles were conducted.

Information was collected in Canadian and U.S. jurisdictions to determine the practicality, usefulness, costs and benefits of school bus pedestrian safety devices.

Rail Safety

Recent work on landslide hazard risk mitigation was based on a CP Rail rock-fall rating assignment. The hazard rating system was revised and a new GPS locator system was instituted. Intensive investigations were carried out at the site of the Hope Slide to determine key factors that may aid in the prediction of similar events.

A multiyear research program aimed at reducing accidents at highway-rail grade crossings covers a broad range of research areas, including driver, pedestrian and vehicle behaviour; enforcement technologies; signal lights and structures; and train-based warning systems. Co-sponsored by Transport Canada, the major Canadian railways and several provincial authorities, the research program is a component of Direction 2006, which aims at halving grade-crossing accidents by 2006.

Transportation of Dangerous Goods

Current field tests on pressure relief valves (PRVs) are showing that tanks with PRVs with large blowdown result in delayed failure, which means more time to respond, reduced failure risk, and reduced fill and hazard if the tank fails.

Static and dynamic tests of tank truck vehicle stability were conducted, entailing the assembly of numerous types of truck combinations from logging trucks to highway tankers with pups. Work to date suggests that there is a strong correlation between a heavy vehicle's static rollover threshold and its rollover risk.

Tank car impact fatigue tests were conducted at the National Research Council Canada's Centre for Surface Transportation Technology facility with fully loaded tanks. Transportation Safety Board labs will provide an analysis of cracks that occurred during testing. TC is also studying the correlation between coupler force and acceleration.

Intelligent Transportation Systems

Researchers at Calgary-based Cell-Loc have developed a small, inexpensive cellular phone-based transmitter specially designed for tracking and are testing this as an alternative traffic-probe approach. This device could offer many advantages over GPS-based locator systems in a broad range of applications.

An operational prototype has been developed of an automatic system that provides real-time identification and cataloguing of rail cars and containers in the Port of Montréal. It uses a combination of an automatic equipment identifier to identify rail cars, and a state-of-the-art optical character reader to read ISO ID codes.

Accessibility

Several visual messaging technologies have been tested, including electronic reader boards, full-text monitors and flight information displays. Electronic reader boards were found to be the most effective in assisting wayfinding in air terminals. Another study examined ways of improving on-board aircraft safety briefings so that they can be better understood by passengers with sensory or cognitive impairments.

Human Factors Research

Research into pilot fatigue aimed at developing strategies and countermeasures found that there are important individual differences in the effect of jetlag on pilot performance and consideration should be given to the effects of natural circadian adjustments of the crew when designing schedules. Data were collected from pilots flying transoceanic commercial routes.

To test the effectiveness of various technological aids in managing the problem of fatigue among commercial motor vehicle drivers, trucks were equipped with various fatigue management technologies. Devices tested included an actigraph, which predicts levels of driver alertness from wrist movements, and PERCLOS, which measures the droopiness of the subject's eyelids. Other devices tracked the vehicle's position on the road, or mechanically kept the vehicle's wheels straight, limiting potentially fatiguing steering corrections.

A fatigue management program is being tested to measure its effects on driver fatigue, safety and motor vehicle operations. Drivers were given baseline field testing, including questionnaires and fatigue measurements such as actigraphy and psychomotor vigilance testing.

Sustainable Development

A growing demand for smaller, cleaner, more energy-efficient vehicles for an urban setting prompted a pilot demonstration of low-speed neighbourhood electric vehicles. A prototype of an energy-efficient, 8.6-metre, low-floor electric bus has been developed and is now ready for testing. Work involved testing various drive options (pure electric, hybrid internal combustion and grid hybrid).

Climate Change

TC's component of the government's Action Plan 2000 on Climate Change is substantial. Five new research programs in the plan are Urban Transportation, Freight Transportation, Vehicle Efficiency, Future Fuels and Fuel Cell Vehicles. The programs take a balanced approach towards vehicle and fuel technology, behaviour change and infrastructure.

Technology Transfer

Transport Canada hosted several workshops and other technology transfer events during the past year, including accessibility; highway-railway grade crossing research; locomotive emissions; aircraft de-icing and anti-icing; Global Aviation Information Networks; and marine navigation and intermodal research.

Moving Forward

Transport Canada will continue to move forward in S&T through its Transportation Blueprint/Vision in the *Innovation Strategy* Agenda; the Federal Innovation Networks of Excellence Initiative; the Chemical, Biological, Radiological and Nuclear Technology Research Initiative; the Climate Change Action Plan; and ongoing involvement with the federal Program of Energy Research and Development.

The kind of forward thinking and innovation that drives Transport Canada's R&D activities is helping to meet the department's goal of creating "the best transportation system for Canada and Canadians."

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WESTERN ECONOMIC DIVERSIFICATION CANADA

Western Economic Diversification Canada's (WD's) priority in western Canada is to strengthen the innovation system. Because innovation occurs at a regional and local levels, the investments required to strengthen the innovation system vary by region, and by the sectors that may form the basis for a cluster. WD's innovation priorities include enhancing technology commercialization, supporting strategic infrastructure and creating more innovative communities. WD also works to enhance the coordination and alignment of innovation priorities and strategies among federal, provincial and other innovation players. WD's focus on innovation is complementary to the Government of Canada's approach.

In 2002–03, innovation continued to be a top priority for WD, provincial governments and the Government of Canada. Industry Canada released *Achieving Excellence: Investing in People, Knowledge and Opportunities*, which identified Canada's innovation challenges of knowledge, performance, skills, innovation environment and strengthening communities. The seven Innovation Summits held in Western Canada identified the innovation priorities of westerners, and they will influence WD's approach to innovation. The priorities of westerners are the following:

- increasing R&D capacity;
- fostering linkages between government, academia and industry;
- enhancing technology commercialization;
- increasing the supply of and access to venture capital;
- improving apprenticeships for skilled workers;
- building an innovation culture; and
- undertaking joint efforts to build on regional strengths.

Over the past year, WD has once again been active in supporting innovation. Approximately 59 percent ($63 million) of WD's new approvals have been made to innovation projects, up from 44 percent in the previous year. Almost half was invested in the life sciences (biotechnology, proteomics, health industries), with the remainder evenly split between information technology (geomatics, e-health, new media) and the physical sciences (fuel cells, climate change technologies, micro-technologies). The initiatives supported reflect WD's innovation priorities: 41 percent of approvals have been directed to technology commercialization activities; 39 percent to enhancing knowledge infrastructure; and the balance invested in activities that improve skills, linkages and R&D. Partners such as provincial governments, other federal departments and the private sector have contributed two-thirds, or an additional $122 million.

The following initiatives are examples of how WD has implemented its strategy. All build on existing strengths such as investments in health research and publicly funded R&D. They also enhance technology commercialization and align innovation priorities among stakeholders, leading to greater synergies and opportunities. WD played a catalytic role in many initiatives, while the Canada West Health Innovation Council (CWHIC) and WestLink have demonstrated an impact on the national innovation agenda.

Canada West Health Innovation Council

Experts predict that over the next 10 years, Canada will invest more than $1 trillion in health and health care, while our annual trade deficit in health products will approach $8 billion. To address this deficit and to capture economic and social benefits from health research, WD worked with Dr. Henry Friesen and leading western Canadian researchers in health and life sciences. Their report, *Shaping the Future of Health Research and Economic Development in Western Canada*, promotes the opportunity to build on health investments as a cornerstone of economic development in Western Canada.

The CWHIC was created to champion this agenda. Led by prominent western Canadians, the Council has developed a strategy of "managed networks" of expertise among provinces to achieve critical mass. Western Canadian researchers have diverse expertise in areas such as cancer genome sequencing, cell biology, clinical trials/drug discovery, robotic surgery techniques, health informatics, telehealth, imaging/biodiagnostics, nutriceuticals and functional foods, plant genomics, population

health, proteomics and nanotechnologies, as well as diseases. This world-class research offers the potential for significant improvements in health care, and the technological breakthroughs may present substantial economic benefits (new investment, export opportunities, and the creation of skilled jobs and new enterprises).

This strategy will provide important links between provincial and national agendas in the area of health research and innovation.

For example, Manitoba has a well-developed health research infrastructure and is home to an emerging life sciences cluster that includes NRC's Institute for Biodiagnostics, CancerCare Manitoba (featuring the Manitoba Institute of Cell Biology and the Genomic Centre for Cancer Research and Diagnosis), the Diabetes Research and Treatment Centre, the Spinal Cord Research Centre, the Manitoba Centre for Proteomics, and the Canadian Blood Services Centre. The research competencies of the University of Manitoba's Medical Faculty include the following:

- pediatrics;
- ophthalmology;
- nephrology;
- neurosciences;
- lipoproteins; and
- liver diseases.

In addition, its work in tele-health is facilitating health research opportunities in rural, remote and isolated communities.

The St. Boniface General Hospital Research Centre, affiliated with St. Boniface General Hospital and the University of Manitoba, is another state-of-the-art medical research facility. With a cohort of 240 researchers and an annual operating budget of $14 million, the Centre is recognized internationally for its research in cardiovascular sciences, respiratory medicine, magnetic resonance imaging, degenerative disorders associated with aging (senile dementia) and other areas. The growing capacity of Manitoba in these areas provides significant opportunities for regional and national collaboration to capitalize on new research and technologies that will benefit all of Canada.

At the national level, CWHIC, along with the Ottawa-based Public Policy Forum, held a national round table in September 2002 with more than 100 leaders in industry, government, academia, the health sector and the investment community, to explore opportunities to take advantage of the link between health research and economic development as part of the Government of Canada's national innovation agenda.

WestLink Innovation Network

The WestLink Innovation Network was established in May 1999, with core funding from WD, to accelerate technology transfer in Western Canada through collaboration, skill building and targeted "gap-filling" programs and services. WestLink's membership includes a network of 25 western Canadian universities, colleges and research institutes. WestLink has created linkages among venture capital firms, university spin-off companies, industry and the legal profession. WestLink offers services in facilitation and communication, skill development and training, and technology bundling in the areas of medical devices and software. Members share best practices.

WestLink's Technology Commercialization Internship program (TCIP), sponsored by WD, NSERC, industry and the four western provinces, is an example of an initiative that increases the skills and experience of youth, builds linkages among the innovation system players and enhances technology commercialization. Eighteen interns (educated in science and business) will complete their two-year program in spring 2003 after specialized training in all aspects of technology commercialization and experience in a technology commercialization office, a venture capital firm and a start-up company. Early benefits of this program have been demonstrated. The next TCIP is scheduled to begin in spring 2003 and will be connected to a similar program being offered in Atlantic Canada.

Petroleum Technology Research Centre

The Petroleum Technology Research Centre is located at the University of Regina. Partners include Natural Resources Canada, the Province of Saskatchewan, WD and the private sector. A private/public board governs it. The Centre brings together researchers from the Saskatchewan Research Council and the University of Regina. Its researchers investigate sustainable methods of improving oil recovery from marginal

wells and extending the lifetime of existing oil reserves. Researchers will be tackling the challenges of increasing production efficiency and addressing climate change.

Significant economic spin-offs are anticipated within the research community and throughout the oil and gas industry. The environmentally and economically sustainable methods developed at the facility to enhance the production and value of oil resources will be put to use by companies across the globe. High-tech employment opportunities will be available to the province's young people, and the results of their research exported.

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