ESTIMATES

Natural Sciences and Engineering Research Council of Canada

Performance Report

For the period ending
March 31, 2000

Canada

Improved Reporting to Parliament
Pilot Document

The Estimates of the Government of Canada are structured in several parts. Beginning with an overview of total government spending in Part I, the documents become increasingly more specific. Part II outlines spending according to departments, agencies and programs and contains the proposed wording of the conditions governing spending which Parliament will be asked to approve.

The *Report on Plans and Priorities* provides additional detail on each department and its programs primarily in terms of more strategically oriented planning and results information with a focus on outcomes.

The *Departmental Performance Report* provides a focus on results-based accountability by reporting on accomplishments achieved against the performance expectations and results commitments as set out in the spring *Report on Plans and Priorities.*

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Foreword

On April 24, 1997, the House of Commons passed a motion dividing on a pilot basis the *Part III of the Estimates* document for each department or agency into two separate documents: a *Report on Plans and Priorities* tabled in the spring and a *Departmental Performance Report* tabled in the fall.

This initiative is intended to fulfil the government's commitments to improve the expenditure management information provided to Parliament. This involves sharpening the focus on results, increasing the transparency of information and modernizing its preparation.

The Fall Performance Package is comprised of 83 Departmental Performance Reports and the President's annual report, *Managing for Results 2000*.

This ***Departmental Performance Report,*** covering the period ending March 31, 2000 provides a focus on results-based accountability by reporting on accomplishments achieved against the performance expectations and results commitments as set out in the department's *Report on Plans and Priorities* for 1999-00 tabled in Parliament in the spring of 1999.

Results-based management emphasizes specifying expected program results, developing meaningful indicators to demonstrate performance, perfecting the capacity to generate information and reporting on achievements in a balanced manner. Accounting and managing for results involve sustained work across government.

The government continues to refine its management systems and performance framework. The refinement comes from acquired experience as users make their information needs more precisely known. The performance reports and their use will continue to be monitored to make sure that they respond to Parliament's ongoing and evolving needs.

This report is accessible electronically from the Treasury Board Secretariat Internet site: http://www.tbs-sct.gc.ca/rma/dpr/dpre.asp

Comments or questions can be directed to the TBS Internet site or to:

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Investing in people, discovery and innovation

Departmental Performance Report

for the period ending March 31, 2000

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John Manley,
Minister of Industry

Executive Summary

The challenge

The next millennium will see a continued expansion of the global knowledge-based economy. Canada's prosperity depends upon people, knowledge and innovation, especially in science and technology, as we transform our economy from one based on commodities to one based on value-added products in all sectors. Science and technology will also continue to enhance our quality of life by helping us improve the management of our resources, environment, public education, and health system.

Who we are

NSERC (the Natural Sciences and Engineering Research Council of Canada) is the national instrument for making strategic investments in Canada's capabilities in science and technology. NSERC functions at arm's length from the federal government. It is funded directly by Parliament and reports to it through the Minister of Industry.

What we do

Our mission is to invest in people, discovery, and innovation to build a strong Canadian economy and to improve the quality of life for all Canadians. NSERC advances government-wide priorities of building a stronger Canada, creating opportunities for young Canadians, and investing in knowledge and creativity.

NSERC supports world-class research and the training of Canada's brightest young people. As a result, Canada has access to leading-edge science and technology from around the world and highly qualified people expert in it. Students trained with the help of NSERC support acquire the skills needed to generate knowledge and pursue rewarding careers in all sectors of society. These investments in Canada's knowledge base lead to innovations in industry and advances in setting policy, standards and regulations, and in solving problems, thus strengthening our economy and improving the quality of life for all Canadians.

Some of our accomplishments

In recent years, NSERC has been successful in:

- maintaining a strong presence in world science and engineering research by supporting annually nearly 9,000 of the most creative and productive Canadian researchers;
- supporting the training of more than 53,000 master's and doctoral students, and young research professionals since 1978, who have had little trouble finding well-paying, productive jobs and who are contributing to Canada's knowledge-based economic sectors;
- supporting the development of new processes and products, some leading to the formation of new companies, all of which contribute significantly to the national economy;
- encouraging Canadian industry to invest more than $600 million since 1978 in university research and training activities.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AUCC	Association of Universities and Colleges of Canada
CCAC	Canadian Council on Animal Care
CFI	Canada Foundation for Innovation
CIHR	Canadian Institutes of Health Research
CMC	Canadian Microelectronics Corporation
CRD	Collaborative Research and Development Grant
CRF	Consolidated Revenue Fund
DPR	Departmental Performance Report
IPM	Intellectual Property Management Program
IRF	Industrial Research Fellowship
MRC	Medical Research Council of Canada
NCE	Networks of Centres of Excellence
NSE	Natural Sciences and Engineering
NSERC	Natural Sciences and Engineering Research Council of Canada
OECD	Organisation for Economic Co-Operation and Development
P	Preliminary
PDF	Postdoctoral Fellowship
PI	Principal Investigator
R&D	Research and Development
S&T	Science and Technology
SSHRC	Social Sciences and Humanities Research Council of Canada
TPP	Technology Partnerships Program
USRA	Undergraduate Student Research Award

1. Messages

1.1 Minister's Portfolio Message

Canada stands at the threshold of the new century as a world leader in the new economy, an economy fundamentally different from that of even ten years ago. In the past decade we have seen unprecedented changes around the world, and Canada has moved quickly to take advantage of the opportunities offered. The forces of globalization mean that we are no longer competing locally, or even regionally, but with economies around the globe. And the pace of change has accelerated at a dizzying speed. New electronic communications and information technologies have hastened our transformation into a knowledge-based economy, where skilled workers are our most significant resource and innovation is the key to success. Canada is in the vanguard of this, and our economy is strong and dynamic.

The Industry Portfolio is …

Atlantic Canada Opportunities Agency
Business Development Bank of Canada*
Canadian Space Agency
Competition Tribunal
Copyright Board Canada
Canada Economic Development for Quebec Regions
Enterprise Cape Breton Corporation*
Industry Canada
National Research Council Canada
Natural Sciences and Engineering Research Council of Canada
Social Sciences and Humanities Research Council of Canada
Standards Council of Canada*
Statistics Canada
Western Economic Diversification Canada

** Not required to submit Performance Reports*

The Government of Canada identified the challenges and opportunities of the new economy at an early stage, and we have been following a clear plan to capture its benefits for all Canadians. A key element of this agenda is investing in research and knowledge, and strengthening Canada's capacity for innovation, in order to increase productivity and to create well-paying jobs to improve our standard of living. We are also investing heavily in human resources, developing the knowledge workers we will need for the economy to continue to thrive, and fostering an entrepreneurial business climate. And we are working to make Canada the most connected country in the world, to maintain our position as a leader in the use of the Internet.

As Minister of Industry, I am responsible for the Industry Portfolio which consists of fourteen departments and agencies that play a key role in delivering on the government's agenda. With over 40% of federal government spending on science and technology, and a wide range of complementary programs to help businesses both large and small thrive and prosper, the Industry Portfolio represents a powerful toolkit for the government as it leads Canada's transition to the new knowledge-based economy and society.

I am pleased to present this Performance Report for NSERC, which shows its contribution to the government's agenda by setting out the commitments made in its

Report on Plans and Priorities, and its success in meeting them over the 1999-2000 fiscal year.

In 1999-2000, NSERC invested $527 million in university-based research and training in all the natural sciences and engineering. Thanks to NSERC's investments on behalf of the Government of Canada, Canadian researchers gain access to leading-edge knowledge from around the world. Armed with this knowledge, and working increasingly in partnership with industry, they help fuel Canada's innovation system. The students, trained with the help of NSERC, acquire the skills needed to pursue rewarding careers in all sectors of the economy and become tomorrow's leaders. These investments in Canada's knowledge base lead to innovations in industry, and help set policy, standards and regulations. In so doing, they strengthen our economy and improve the quality of life for all Canadians.

Working together to invest in our people and our future, we are making our country a stronger and more prosperous place for all Canadians. I am proud of the Industry Portfolio's significant contributions toward meeting these government priorities.

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The Honourable John Manley

1.2 Message from the Secretary of State (Science, Research and Development)

Our investments in research and innovation are guided by a vision whereby the future belongs to societies whose economies are sound, whose populations are healthy, whose children are prepared, and whose stakeholders invest in the knowledge, education and innovation of their people. The search for knowledge must be an ongoing process as it touches all facets of our lives---health, humanities and social sciences, education, environment, business and the economy. The Government continues to invest in knowledge to reinforce our competitiveness, improve the well-being and the quality of life of Canadians, and make Canada a location of choice for knowledge workers and entrepreneurs to live and work.

We still face a productivity challenge in Canada, but the government's innovation agenda is meeting this challenge. We are training our researchers to be world class, and we are giving them world-class facilities and opportunities in Canada. Portfolio partners carry out critical research in key areas, and support the development of the physical and knowledge infrastructure that the new knowledge-based economy needs.

It is also essential for our leading-edge research to be turned into cutting-edge products and services, and to this end the Portfolio partners provide strategic support to businesses. We must aim to lead the world in the development and adoption of new technologies, just as Canada has become a world leader in connectedness and getting businesses and individuals to realize the opportunities of the Internet. And we must encourage our businesses to see themselves as world-class entrepreneurs – people with the know-how and the drive to market new ideas and services.

This Performance Report for 1999-2000 gives concrete examples of how the government, through NSERC is encouraging partnerships, promoting innovation, and investing in research to generate new ideas for our society and economy. NSERC has invested in university researchers and students to help Canada maintain a strong presence in world science and engineering; to train young research professionals, who have had little trouble finding well-paying, productive jobs; to support the development of new processes and products, some leading to the formation of new companies, and to encourage Canadian industry to invest more in university research and training activities.

We will continue to focus on innovation and excellence, working together to achieve a stronger and more prosperous country for all.

_____

The Honourable Gilbert Normand

2. Departmental Performance

2.1 Societal Context

Objectives:

The Council's ultimate objective is to advance Canada's prosperity and high quality of life by supporting the creation and transfer of knowledge in the natural sciences and engineering (NSE) in Canada, and by ensuring people are trained to use and create that knowledge. To achieve this, NSERC supports research in Canadian universities and colleges that meets the highest international standards of excellence and it supports the education of young people in that research.

As a result, Canada has access to leading-edge science and technology from around the world and highly qualified people expert in it. Partnerships with industry connect researchers with those who can use the new knowledge productively and enhance Canada's capacity for innovation. Innovation contributes to wealth creation in the economy, which produces prosperity. New knowledge in NSE also enhances our quality of life through its impact on many policies, regulations, practices, and institutions.

Strategic Priorities:

This next century will see the global, knowledge-based economy create tremendous opportunities for greater prosperity and improved high quality of life for all Canadians. We must seize these opportunities and build on our strengths. "In the global, knowledge-based economy, the advantage goes to countries that are innovative, have high levels of productivity, quickly adopt the latest technology, invest in skills development for their citizens, and seek out new opportunities around the world."[1]

It is with this in mind that NSERC undertook a year-long review of its strategy. NSERC's previous strategy document was published in 1994 and since then the research environment has changed dramatically.

Canadians increasingly recognize the importance of research and development and the role it plays in our economy and quality of life. The federal government is significantly investing in university research (e.g. the Canada Foundation for Innovation, the Networks of Centres of Excellence, the granting council budgets, the Canadian Institutes of Health Research, and the Canada Research Chairs).

NSERC concluded that the environment within which the Council operates is changing so rapidly that publishing a strategy document every few years will no longer do. Rather, NSERC's strategy must become an ongoing planning process. NSERC must be flexible,

[1] Speech from the Throne, *Building a Higher Quality of Life for All Canadians,* October 12, 1999, p. 8.

innovative, strategic and responsive to meet the changing needs of the Canadian natural sciences and engineering research community. At the same time, NSERC will preserve its core priorities of investing in **discovery** and **innovation** and the **people** who make it happen.

Two other conclusions of the strategy review are worth noting. First, NSERC has expanded its eligibility to include colleges. Shifting from the current practice, colleges in partnership with universities are now eligible for project research funding. NSERC will review this change in two to three years and consider expanding college eligibility to other NSERC program funding.

The second conclusion relates to NSERC's influence. While NSERC is already influential in areas beyond its program reach as a federal agency, there are several ways in which NSERC plans to become more influential. NSERC is becoming actively engaged in science promotion by assuming the responsibility for the Michael Smith Awards for Science Promotion and creating a new PromoScience program. Through these programs NSERC hopes to influence young Canadians' interest in science and engineering and encourage them to pursue studies in those areas and consider related career goals.

NSERC's Strategy is available at the following Web address: www.nserc.ca/publicat.htm.

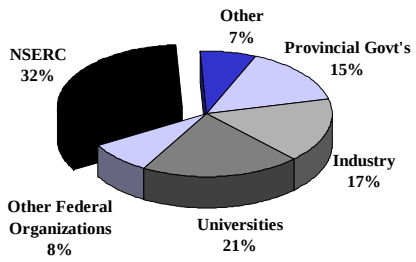
Key Co-Delivery Partners:

NSERC does not conduct any research in-house, nor does the organization have any training facilities. NSERC supports research in Canadian universities and colleges that meets the highest international standards of excellence and it supports the education of young people in that research. As a result, the universities, colleges, companies, government agencies, and other institutions that NSERC collaborates with are all key co-delivery partners. A brief summary of NSERC's partners is presented below.

Universities

NSERC is the single most important funder of research and development (R&D) in the natural sciences and engineering in Canadian universities. In 1999, $1.3 billion in R&D was carried out by Canadian universities in the natural sciences and engineering. NSERC directly provided one-third of the total funding. Since much of the other funding from universities, industries and governments is contingent upon

Figure 1: University R&D Funding in the Natural Sciences and Engineering, 1999



Total: $1.3 Billion

Source: Statistics Canada

NSERC funding, a reasonable estimate makes the Council directly and indirectly responsible for slightly more than half of the funding. Figure 1 gives a breakdown of the total funding by direct source. (See Section 6.4 for more statistics on the importance of Canadian university research.)

More than 8,700 university researchers and nearly 15,000 university students and postdoctoral fellows are supported by NSERC. The Council also supports a considerable number of university technicians. Most Canadian universities benefit from NSERC programs, as do a growing number of industries and government departments. Figure 2 presents the details of NSERC's client support. Estimates of the share of the population funded or participating, for eligible individuals and organizations, and trends over the past ten years, are also included.

Figure 2: NSERC's Clients and Partners, 1999-2000

	Number Supported or Participating	Share of the Population[1]	Trends in Share of the Population Over Past 10 Years
Clients:			
University Researchers	8,734	60% – 65%	Small Increase
Undergraduate Students	5,609	5%	Small Increase
Master's/Doctoral Students	7,759	35% - 40%	Stable
Postdoctoral Fellows	1,497	40% - 50%	Stable
University Technicians and Research Professionals	3,143	30% - 40%	Stable
Partner Organizations:			
Universities	62	75%	Stable
Companies Performing R&D[2]	649	9% - 11%	Nearly Doubling
Federal Science Departments/Agencies[2]	12	65%	Large Increase
Provincial Science Departments/Agencies[2]	12	25% - 40%	Large Increase

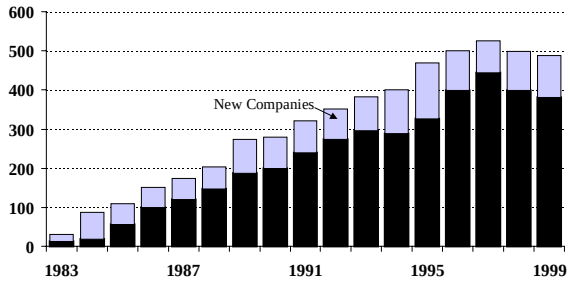
Source: NSERC

1. The percentage that NSERC supports of all individuals and organizations eligible for NSERC funding.
2. Organizations in partnership with NSERC (across all NSERC programs).

Companies

Strong growth has taken place in the number of companies that have contributed to NSERC's collaborative university-industry research programs (see Figure 3). Since the inception of the university-industry research programs, more than 1,300 firms have participated, rising from less than 50 companies in 1983 to nearly 500 businesses in 1999. On average, 100 new firms are working with NSERC every year.

Figure 3: Number of Companies Contributing to NSERC's University-Industry Programs



Source: NSERC

NSERC is well known to companies heavily involved in R&D. Thirty-two of the top 50 Canadian R&D companies (as ranked by The Globe & Mail, 1999) have funded university research jointly with NSERC.

Government Departments/Agencies

NSERC is also well known to most federal and provincial science-based departments and agencies. A list of federal and provincial departments and agencies NSERC has collaborated with in 1999 is presented in Figure 4.

Figure 4: NSERC's Federal/Provincial Partners, 1999-2000

Federal Departments/Agencies	Provincial Departments/Agencies
Agriculture and Agri-Food Canada	Alberta Advanced Education
Canadian Institutes of Health Research (formerly MRC)	Alberta Energy
Canadian Space Agency	Alberta Environmental Protection
Cape Breton Development Corp.	Forest Renewal BC
Environment Canada	Government of Newfoundland and Labrador
Fisheries and Oceans Canada	Manitoba Energy and Mines
Health Canada	Fonds FCAR (Quebec)
National Defence	Ministry of Environment (Quebec)
National Research Council Canada	Ministry of Natural Resources (Quebec)
Natural Resources Canada	Ministry of Transportation (Quebec)
Public Works and Government Services Canada	Ontario Ministry of Agriculture
Social Sciences and Humanities Research Council of Canada	Saskatchewan Energy and Mines

Social and Economic Factors:

The short-term challenges NSERC faces are briefly described in Figure 5. The social and economic factors at work are likely to strain current NSERC funding.

Figure 5: Challenges Facing NSERC

The rising cost of research

The cost of performing leading-edge, world-class research is rising, creating greater dependence on NSERC funding. This is due to: (1) the weak Canadian dollar makes it expensive to import scientific instruments; (2) the prices for tools like scientific monographs and journals are going up much faster than the Consumer Price Index (CPI); (3) to conduct world-class research, Canadian researchers must adopt new and expensive research methods; and (4) many university research services that used to be free now carry user fees that must be paid out of NSERC grants.

Impact of the Canada Foundation for Innovation

Over the next several years, the federal investment of $1.9 billion for the Canada Foundation for Innovation (CFI) will translate into over $5.5 billion in investment in much-needed infrastructure. However, while the CFI will strengthen the capacity of Canada's universities to conduct research, it will also create challenges for all sectors. NSERC, which funds the direct costs of research, anticipates a large increase in the demand for funding to operate the new facilities and laboratories. Calculations estimate an increase in demand for NSERC funding by at least $135 million per year.

The demand for highly skilled people

Canada's success in the new economy is increasingly dependent on its human capital. However, young talented people are often lured south of the border with higher salaries and research funding at leading-edge facilities. As a result, universities have difficulty attracting postdoctoral fellows and junior researchers. Moreover, many Canadian companies report that they cannot find highly skilled individuals in some fields, notably engineering and computer science.

The loss of leaders

While the debate over "brain drain" or "brain gain" may never be resolved, it is certain that Canadian universities are losing some highly qualified faculty and these tend to be the leaders. "Loss of leaders" should perhaps replace "brain drain" as our greatest concern. As highly paid senior professors retire or relocate, often outside Canada, universities have tended to replace them with junior faculty resulting in a loss of research and training capability at our universities, at least in the short term.

Growing number of researchers to support

NSERC has to support a growing number of researchers. There are several reasons for this. First, all new faculty members are expected to conduct research; they must be supported at a critical time in their career even though those being replaced were not all active in research. Second, some early retirees who were active in research stay on as unpaid professors; they continue to win support in NSERC competitions. Both trends are good for Canada, but they create pressures on NSERC's budget.

Government-Wide Priorities:

NSERC's investments continue to support the government-wide priorities as described in the October 1999 Speech from the Throne. In the following sections it will be clearly demonstrated that NSERC's funding is contributing to the realization of government-wide priorities in the areas of (1) creating a dynamic economy, (2) assisting young Canadians to find work, develop and apply new skills, (3) helping to improve the environment through new science and engineering discoveries, (4) contributing to the improved health of Canadians, and (5) assuming Canada's prominence in world science.

2.2 Performance Expectations and Chart of Key Results Commitments

NSERC measures its performance by evaluating its programs of research and training support, their impact, cost effectiveness and continuing relevance. When reviewing performance of research support programs, it is important to remember that these investments take longer to bear fruit than most other government investments.

Performance expectations detailed below are taken from the Report on Plans and Priorities and are summarized in the Chart of Key Results Commitments (see Figure 6). Highlights of performance expectations to **serve Canadians** include:

- high-quality research capability maintained across all areas of the natural sciences and engineering;
- enhanced ability to access and use new knowledge from around the world;
- knowledge base for developing policies and regulations, and making decisions, for government and industry;
- creation and productive use of knowledge in support of new products, processes, services, policies, standards and regulations in private and public sectors;
- highly qualified personnel to meet the needs of industry and the public sector;
- stronger economy based more on knowledge due to more technology transfer via highly trained employees in the public and private sectors, and through the creation of new businesses by trained individuals.

Figure 6: Chart of Key Results Commitments

NSERC (the Natural Sciences and Engineering Research Council of Canada) is in business

to provide Canadians with:	to be demonstrated by:	achievement reported in:
economic and social benefits arising from the provision of a highly skilled workforce and knowledge transfer of Canadian discoveries in the natural sciences and engineering from universities to other sectors	a highly skilled workforce, with a base of expertise across the natural sciences and engineering fields	
	➢ trends in employment and career status of former scholars and fellows	DPR Section 2.3.2
	an advanced knowledge base which is vital as a source of economic and societal benefits for Canada, in the short and long term	
	➢ high-quality research results, as assessed by internationally accepted standards	DPR Section 2.3.1
.	application of knowledge leading to new policies, standards and/or regulations	
	➢ incidence and impact of contributions of researchers and/or their research results to the formulation of public policies, regulations and standards	DPR Section 2.3.1
	creative and productive use of knowledge for new products and services, leading to new jobs and businesses	
	➢ trends in the numbers of collaborative partnerships supported by NSERC, between the university and private/public sector	DPR Section 2.3.1
	➢ economic impact of NSERC-supported research	DPR Section 2.3.1

2.3 Performance Accomplishments

The impact of NSERC's investment in research and training in the NSE can only be fully assessed over the long term. As well, no one indicator can be considered a defining accomplishment; rather the whole suite of indicators presented should be taken into consideration. The performance indicators are presented within two categories: (1) discovery and innovation, and (2) people.

NSERC is also addressing performance issues in its administration activity, including quality service initiatives. The goal of the administration activity is to support and underpin the Council's function; performance issues therefore revolve around efficiency and quality service to both Council's staff and the research community. Performance in administration will be discussed in future Performance Reports, after performance baselines have been established. Current initiatives are described in 2.3.3.

2.3.1 Discovery and Innovation

Across all its programs NSERC invested $321 million on discovery and innovation in 1999-2000. (This total excludes all expenditures on undergraduate/master's/doctoral students and postdoctoral fellows, which will be discussed in section 2.3.2.) The results of this and prior investments are described below under ten indicators:

1. Publications
2. Collaboration/Partnerships
3. Patents
4. Awards and Prizes
5. Licences
6. Leveraging
7. Industrial Survey Results
8. Companies Linked to NSERC-Funded Research
9. New Products and Processes
10. Success Stories

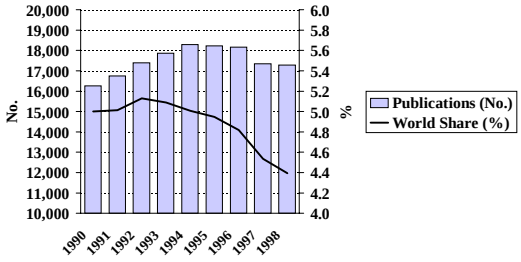
1. Publications

One of the first tangible outcomes of an investment in university R&D is a publication in a scientific or engineering journal. The worldwide culture of university research places a great deal of importance on publishing new discoveries and advances in widely circulated journals. Investment in this very public forum gives the country's researchers access to the latest international research and the ability to build on this research. The graphs on the following pages highlight some performance trends.

1. Publications (Cont'd)

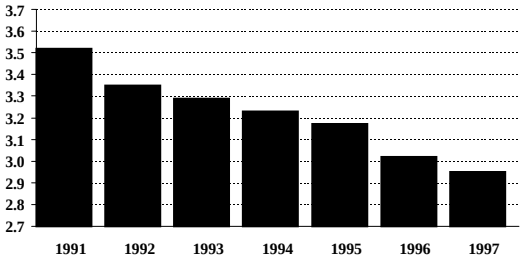
- Canadian researchers (all sectors) in the NSE publish roughly 17,000 journal articles per year, ranking Canada 6th overall in the world. This has represented a declining share of worldwide production, from 5% at the beginning of the decade to 4.5% in 1998 (see Figure 7). Most of Canada's and the world's scientific and engineering publications are produced by university researchers. The decline in Canada's share of university research spending in the OECD (Organisation for Economic Co-Operation and Development, a good approximation for the world scene), as shown in Figure 8, follows roughly the same pattern as our world share of publications. However, Canada's world share of publications still exceeds Canada's share of university R&D expenditures.

Figure 7: Number of Canadian Publications in the NSE and World Share



Source: Observatoire des Sciences et des Technologies

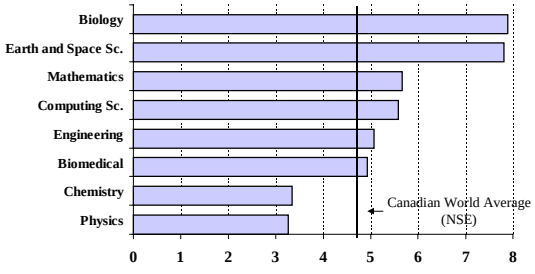
Figure 8: Canada's Share of University R&D Expenditures in the OECD (%)



Source: OECD

- One of the important objectives for NSERC is to maintain a significant world presence in all fields of the natural sciences and engineering. Figure 9 indicates that for the most part this is being accomplished.

Figure 9: Canada's Share of World Publications by Discipline in the NSE, 1990-98 (%)

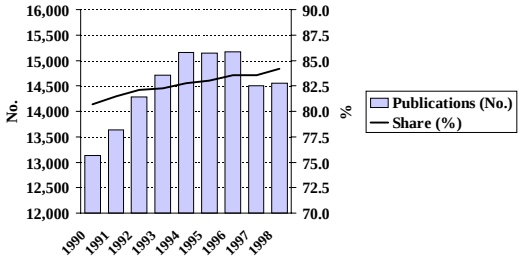


Source: Observatoire des Sciences et des Technologies

1. Publications (Cont'd)

- Most of Canada's NSE publications are produced by university researchers (see Figure 10). Of the average 15,000 university papers produced annually, over 80% can be attributed to NSERC-funded researchers.

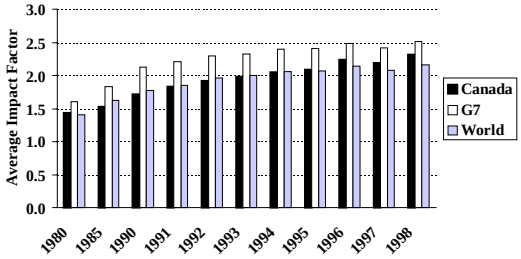
Figure 10: Number of Canadian Publications in the NSE by the University Sector, and Share of Canadian Papers



Source: Observatoire des Sciences et des Technologies

- Figure 11 provides an indication of the "impact" of Canadians papers in the NSE. Similar to common rating systems, in which a higher score indicates more viewers, listeners, or readers, the impact factor is a measure of the potential use of a researcher's work by fellow researchers. If a researcher's work is being referenced or cited more often by his/her peers, then there may be more intrinsic value to the work. Canada's impact factor in the NSE is slightly better than the world average and slightly below the G7 (although the latter gap is narrowing).

Figure 11: Average Impact Factor of Publications in the NSE

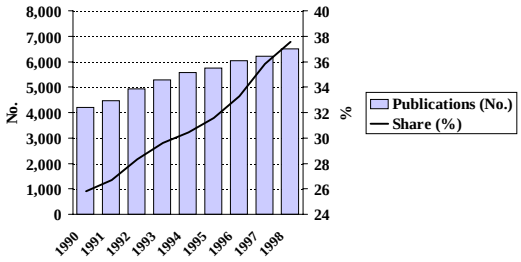


Source: Observatoire des Sciences et des Technologies

2. Collaboration/Partnerships

Increasingly Canadian researchers in the NSE are collaborating with international partners and benefiting from the globalization of R&D. Figure 12 shows the trend over the past nine years, culminating in more than one-third of Canadian papers in the NSE being written with international partners.

Figure 12: Number of Canadian Publications in the NSE Co-Authored with International Partners, and Share of Canadian Papers

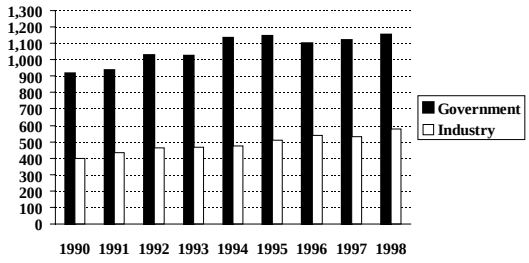


Source: Observatoire des Sciences et des Technologies

2. Collaboration/Partnerships (cont'd)

Canadian university researchers are also working closely with researchers in Canadian government laboratories and industry. Figure 13 indicates that over 1,000 university-government publications and on average 500 university-industry publications are produced annually. This trend has been fairly steady over the past decade. A number of the university-government collaborations result in changes to government policy, as illustrated in the story below.

Figure 13: Number of University-Industry and University-Government Publications in the NSE



Source: Observatoire des Sciences et des Technologies

University-government collaboration improves water quality

Steve Hrudey's combined expertise in risk assessment and water quality have made him as important in policy and regulatory circles as he is in academic research. Canada became the first country in the world to adopt a Drinking Water Guideline concerning microcystin-LR following his research on the potential health hazards posed by that highly toxic cyanobacteria. A similar policy was soon implemented by the World Health Organization. Dr. Hrudey is a professor of Public Health Sciences at the University of Alberta. He and his team provided the first published evidence of the ability and limitations of full scale water treatment plants to remove microcystins. That work contributed to a major risk management guidance manual for water utilities.

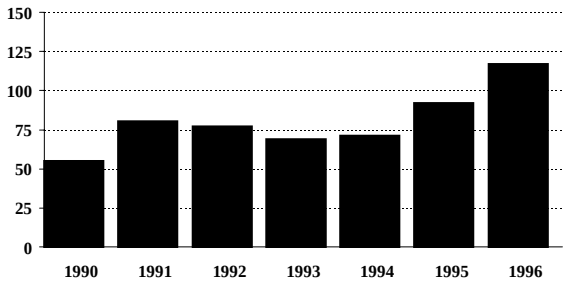
Dr. Hrudey's research program includes a study of the unintended by-products created by a reaction between disinfecting chemicals and natural organic matter in drinking water. He is also identifiying the potential health risks posed by those chemical by-products.

Dr. Hrudey collaborates with researchers in government laboratories, including Environment Canada's National Water Research Institute, Alberta Environmental Protection, and the Saskatchewan Research Council. Some of his graduate students have gone on to work for the Alberta Ministry of Health and the Alberta Research Council. NSERC has supported Dr. Hrudey's research, both in risk assessment, and in water quality.

3. Patents

A patent is issued when an invention is deemed to be new, useful, and nonobvious. Universities are paying closer attention to the potential value of R&D carried out on their campuses, and are seeking patent protection. A good measure of this activity is the number of U.S. patents being issued to Canadian universities. These have increased in the past two years (see Figure 14), but the 1996 level still falls behind the number of patents issued to U.S. universities by approximately 50% (after factoring in the different sizes of the countries).

Figure 14: Number of U.S. Patents Issued to Canadian Universities in the NSE

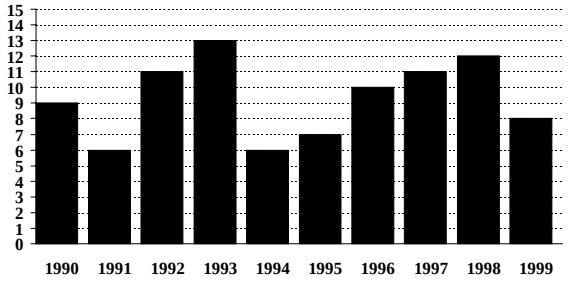


Source: Observatoire des Sciences et des Technologies

4. Awards and Prizes

Awards and prizes are a very common tribute to excellence in the research community. NSERC collected data on 191 international awards and prizes. Over the past ten years NSERC-funded researchers have received roughly 3% of the awards and prizes included in the analysis. (See Figure 15.)

Figure 15: Number of International Awards and Prizes Won by NSERC-Funded Researchers



Source: NSERC

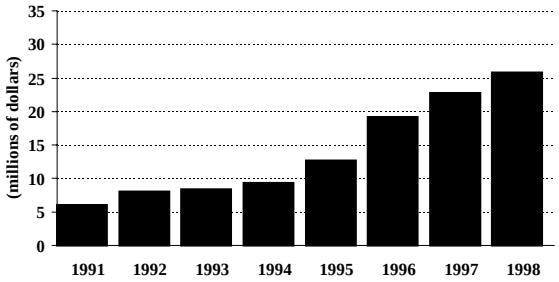
5. Licences

One way university research is transferred to industry is through a licence, giving the industrial buyer the right to commercialize the research. Commercial use of the licensed technology results in royalty income to the university and typically the researcher. The amount of licensing royalty revenues is another measure of the value of university research. Figure 16 presents an estimate of licensing revenues for Canadian universities. Most of these revenues can at least be partially attributed to funding from NSERC and the Canadian Institutes of Health Research (CIHR). The trend in revenue growth is

5. Licences (Cont'd)

certainly a positive one and as universities strive to secure additional revenues it should continue to grow. But for now, Canadian university licensing revenues are far below U.S. university levels by a factor of at least two, even after taking into account the relative expenditures on university research in each country.

Figure 16: Canadian University Licensing Revenue (millions of dollars)



Source: NSERC estimate, Association of University Technology Managers..

Examples of licences based on NSERC-funded research include:

- NSERC-funded researchers in the department of microbiology and infectious diseases at the **University of Calgary** have developed a vaccine against giardia, otherwise known as beaver fever. This year, the vaccine has been licensed to American Home Products and is now commercially available for dogs. A cat vaccine is expected soon.

- Dwayne Hegedus and Thomas Grigliatti at the **University of British Columbia** developed a new gene expression system that simplifies production of high-value recombinant proteins in insect cells. The system uses insect cells to make a variety of valuable recombinant proteins, such as cytokines and growth factors, peptide hormones and protein drugs for infectious diseases. This system, InsectSelect, was licensed to Vancouver's InCell Technologies in 1999. Drs. Hegedus and Grigliatti receive NSERC grants.

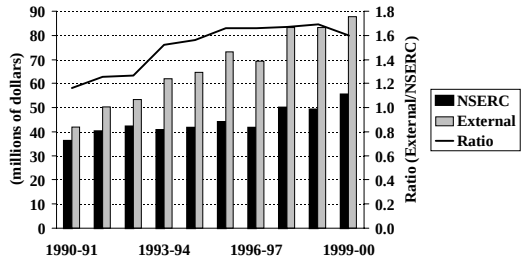
- With his graduate student David Tompkins, Dr. Faouzi Kossentini, an assistant professor of electrical and computer engineering at the **University of British Columbia**, licensed a fast MMR decoder to Image Power Inc. a company that provides still image compression technology and products for the desktop, embedded and Internet imaging markets. Dr. Kossentini receives NSERC grants. This year Mr. Tompkins received his second NSERC postgraduate scholarship.

- Researchers from **Queen's University's** departments of biology and biochemistry have licensed their novel insect antifreeze protein to A/F Protein Inc., a firm based in the U.S. and Canada. The technology has potential applications in the preservation of donor organs, the development of cold-tolerant crops, and as a frozen food preservative.

6. Leveraging

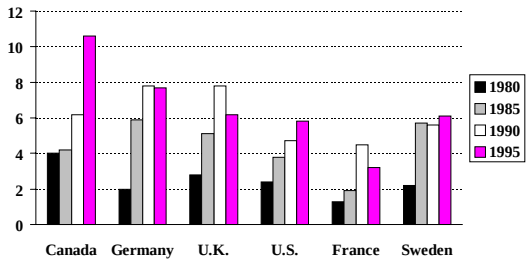
Many of NSERC's programs, and especially the university-industry programs, require a contribution from industry, universities, government departments and agencies. Over the past ten years, contributions from NSERC's partners have grown tremendously. (See Figure 17.) From just over $42 million in 1990-91, contributions in 1999-2000 reached $88 million, for a growth rate of 110 per cent over the ten-year period. The total contribution from NSERC partners over the decade is an impressive $670 million. A comparison of NSERC funding to partner contributions is also presented in Figure 17. The ratio of partner contributions to NSERC funding has increased over the 10 years. From a low of 1.2 in 1990-91, this ratio now stands at 1.6. Put another way, for every dollar NSERC puts on the table for a University-Industry research grant, our partners contribute $1.60, demonstrating the value they place on the R&D. The impact of NSERC's and CIHR's partnership programs has been to increase the share of university research funding from industry to levels well beyond other industrialized nations. (See Figure 18.)

Figure 17: Contributions to NSERC's University-Industry R&D Programs



Source: NSERC

Figure 18: Share of University Research Funded by the Private Sector (%)



Source: OECD

7. Industrial Survey Results

NSERC tracks the outcomes of the Collaborative Research and Development (CRD) program, a program that brings university researchers and industrial partners together. A summary of the industrial participants' perceptions of their CRD experience and some short-term outcomes are described below:

- Of the 64 projects studied to date, 92% of the industrial partners felt that the research objectives of the project were met.

- More than 20% of the industrial collaborators interviewed stated that "new products, processes, standards or services" were created as a result of the

projects, 37% mentioned "improvement of existing processes or products," 86% "updating knowledge" and 25% experienced "improvement to product quality" through the CRD projects.

- A total of 15 patents and 12 licences have so far been issued with respect to the 64 projects examined. According to the industrial partners, commercializable results were achieved for two-thirds of the projects.

- 50% of university researchers indicated that their participation on the CRD project allowed them to bring real world examples into the classroom, and the practical experience and industrial exposure their students received was a tremendous benefit.

8. Companies Linked to NSERC-Funded Research

The creation of a company remains one of NSERC's more tangible outcomes of university-funded research. The "spin-off" companies highlighted in this report have all been founded on results of research partially funded by NSERC. The 111 "spin-off" companies featured (see Figure 19 on the next page) are currently in business producing goods and services for Canadian and international markets. Combined, these companies employ 7,542 Canadians and generate nearly $1.3 billion in annual sales/revenue. Creating innovative goods and services using the latest technologies, these firms make an important contribution to Canada's economy. The potential for future growth of many of these advanced technology companies, which may be tomorrow's multi-nationals, is high. They range in size from new start-ups with only a few employees to well-established firms with hundreds of workers. The number of employees and annual sales/revenue figures by province are shown in Table 16 in Section 6.5.

Figure 19: Companies Linked to NSERC-Funded Research, 1969 to 1999
(Number of employees in Canada in 1999)

Alberta
Raylo Chemicals (175)
BIOMIRA (160)
Wi-LAN (65)
D.B. Robinson and Associates (56)
Harding Instrument Company (41)
Hycal Energy Research Laboratories (40)
Itres Research (35)
SemBioSys (22)
Cell-Loc (20)
Boreal Laser (5)

Saskatchewan
SED Systems (250)
Wavecom Electronics (155)
DEL-AIR Systems (100)
Sci-Tec (93)
Venmar CES (60)
Biostar (32)
Droycon Bioconcepts (8)

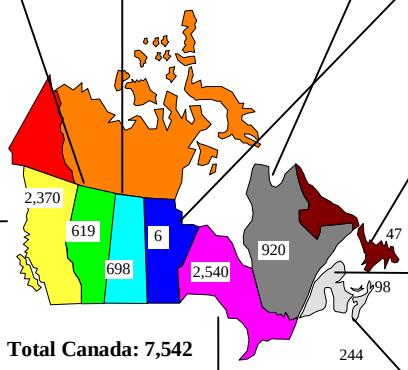
Quebec
BioChem Pharma (438)
Les entreprises GIRO (120)
AD OPT Technologies (60)
Pyrovac International (45)
Nexia Biotechnologies (38)
Hexavision (35)
Advitech Solutions (25)
Infolytica (24)
INRO Consultants (23)
Comlab (22)
Kemestrie (18)
NeoKimia (18)
Tekna Plasma Systèmes (18)
DephyTech (10)
Bios Inc. (10)
Mycota (10)
Real Numerix (6)
Cosem Neurostim (Confidential)

British Columbia
MacDonald Dettwiler and Associates (1400)
NEC Moli Energy (350)
QLT PhotoTherapeutics (175)
Brooks Automation (Techware) (100)
CTF Systems (60)
Westport Innovations (55)
Forbes Medi-Tech (34)
Terragen Diversity (34)
TIR Systems (25)
Vortek Industries (25)
Phero Tech (22)
Credo (Kinetic Effects Research) (13)
IGT Pharma (13)
Barrodale Computing Services (11)
Wavemakers Research (9)
Kinetic Sciences (8)
Intertech Systems (8)
Assistive Listening Device Systems (7)
Mycologic (7)
Quantum Technology (6)
Albacore Research (6)
Dewey McMillin & Associates (5)
Process Stimulations (5)
Aurora Instruments (Confidential)

Manitoba
Sysmon (6)
Quantic Laboratories (Confidential)

Newfoundland
Guigné International (30)
A/F Protein (10)
Northern Radar (7)

New Brunswick
Unisys (70)
EMR Technologies (28)



Total Canada: 7,542

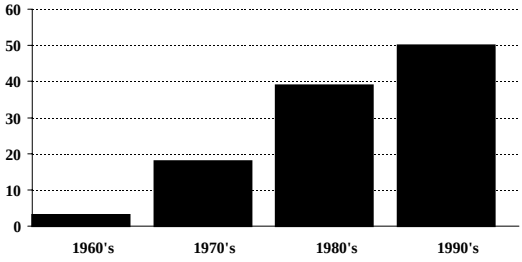
Nova Scotia
Focal Technologies (80)
Applied Microelectronics (50)
Satlantic (40)
Pictorius (30)
Ocean Nutrition Canada (29)
MathResources (8)
Thermo Dynamics (7)

Ontario
ZENON Environmental (400)
MDS SCIEX (320)
Sybase Waterloo (230)
DALSA (195)
Inverpower Controls (175)
Open Text (140)
Honeywell Hi-Spec Solutions (130)
Waterloo Maple (100)
Certicom (95)
Optech (90)
Stantec Consulting Ltd. (80)
Platform Computing (60)
Virtek Vision (52)
E-TEK Electrophotonics Solutions (51)
COSMAX Powerlasers (40)
Imaging Research (38)
Diffracto (33)
Philips Analytical (31)
Ensyn Technologies (30)
Innova Technologies (30)
Performance Plants Biotechnology (28)
TurboSonic (22)
Legasys (21)
Dynacon Enterprises (20)
Engineering Seismology Group (18)
Polyphalt (15)
Hydromantis (14)
Millennium Biologix (12)
Right Track CAD (10)
SMT Hydrasil (10)
Estco Energy (9)
Biorem Technologies (7)
Apollo Environmental Systems (6)
Qubit (6)
Elstat (5)
EnviroMetal Technologies (5)
Gensel (5)
Ask Science Products (4)
New Orbit Technologies (3)

8. Companies Linked to NSERC-Funded Research (Cont'd)

The pace of "spin-off" company formation seems to be accelerating (see Figure 20). As more researchers embrace the entrepreneurial spirit to launch a company, NSERC expects more and better things to come in the future.

Figure 20: Number of NSERC-Related Spin-off Companies by Decade of Incorporation



Source: NSERC

As of June 2000, 20 of the 111 spin-off companies examined are now publicly traded firms. Although the gyrations of the markets have been significant in recent months, the market capitalization of these 20 publicly traded firms on June 12, 2000 was a staggering $14.5 billion (see Figure 21).

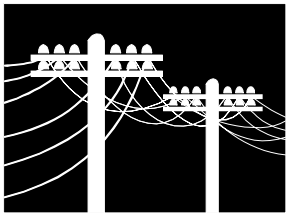
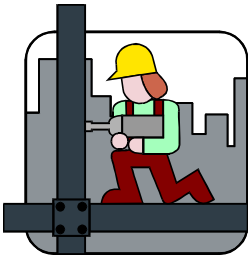
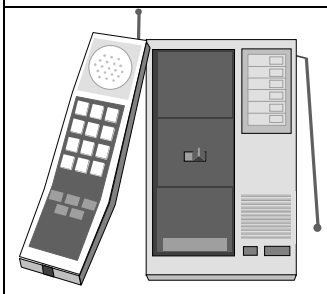
Figure 21: Market Capitalization of Spin-Off Companies

Company	Market Capitalization June 12, 2000
QLT PhotoTherapeutics	$6,152 M
BioChem Pharma	$3,607 M
Certicom	$896 M
Wi-LAN	$852 M
Open Text	$845 M
BIOMIRA	$674 M
Cell-Loc	$491 M
Westport Innovations	$359 M
Forbes Medi-Tech	$155 M
ZENON Environmental	$153 M
Stantec Consulting	$95 M
AD OPT Technologies	$62 M
Virtek Vision International	$53 M
DALSA	$49 M
Gensel	$22 M
Innova Technologies	$21 M
TIR Systems	$6 M
Inverpower Controls	$2 M
Total	$14,494 M

9. New Products and Processes

NSERC-funded researchers have created or developed many new products and processes, the value of which is easily in the billions (although it is very difficult to determine the exact amount). A sample of these new products and processes by economic sector is presented in Figure 22.

Figure 22: Examples of New Products and Processes Developed by NSERC-Funded Researchers, by Sector

 **Energy**	➢ HPDI, High Pressure Direct Injection for converting diesel engines to natural gas ➢ PetroTag, a system for monitoring the mass, density and volume of fuel in storage tanks ➢ Molicel rechargeable lithium-ion battery ➢ Solar Boiler domestic solar water heating system ➢ Battery Health Manager battery management system ➢ RPT, Rapid Thermal Processing for fuel recovery from wood residues and biomass
 **Construction**	➢ High-performance asphalt ➢ Stantec pavement analysis system ➢ Instrumented bridges ➢ High-performance concrete ➢ Acoustic emissions monitoring systems ➢ Light Pipes, a lighting system for inaccessible areas ➢ Heat exchangers for homes, offices, and livestock barns ➢ Corrosion-resistant (composite) materials for bridges and buildings ➢ Pavement engineering technologies for roads ➢ Waste plastics-based binder for asphalt and roofing products
 **Telecommunications**	➢ Fibre optic filters, components ➢ Hopper and Hopper Plus wireless modems ➢ Speech compression software ➢ SQL Anywhere Studio: mobile database technology ➢ CELLOCATE™ System pinpoints exact location of cell phone for safety reasons ➢ Digital Video Modulator for video-on-demand applications ➢ Self-healing and self-organizing networks
 **Earth Observation Systems**	➢ CARIS spatial information and GIS solutions for marine and land based ➢ Shoals-Hawkeye airborne lidar bathymeter ➢ *casi* digital imaging spectrograph for airborne remote sensing ➢ SWR, Surface Wave Radar ➢ DRUMS™, Dynamically Responding Underwater Matrix Sonar ➢ Civilian multi-satellite capable Earth observation centres

10. Success Stories

The following are examples of NSERC-funded research projects that have improved the quality of life, health, or prosperity of Canadians or that have brought international prestige to Canada by significantly contributing to the advancement of knowledge. NSERC has collected hundreds of similar success stories and will present a selection of them in every performance report.

Saskatchewan research is a breath of fresh air

North America's first cost-effective, energy-efficient home, known to most of us as the R-2000, was built using important design and construction concepts developed by Robert Besant. This University of Saskatchewan mechanical engineer developed the first heat-recovery ventilator specifically for energy-efficient home ventilation. The system recovers the energy from stale exhaust air and uses it to warm the fresh air coming into the house, resulting in better air quality. The system has been especially beneficial for people with asthma or allergies. NSERC has supported Dr. Besant's research throughout his career. In addition to his contributions to the R-2000 home, Dr. Besant’s work has found its way into two successful Saskatchewan spin-off companies, DEL-AIR Systems and Venmar CES.

Technology designed with people in mind

Technology should work for people, not the other way around. This is not just a matter of comfort or convenience. If airplane pilots are confronted with a poorly designed system, the result can be deadly for all aboard. Yet few systems are designed with the user in mind. That's why Kim Vicente's work is so important. Dr. Vicente, a professor of mechanical and industrial engineering at the University of Toronto, is a specialist in human factors engineering. He is building an international reputation for his work, most recently through his acclaimed book "Cognitive Work Analysis: Towards Safe, Productive, and Healthy Computer-Based Work." He has improved or simplified all kinds of systems in an array of environments, from nuclear power plants to aircraft, to hospitals.

10. Success Stories (Cont'd)

Smart strategies for staying healthy and fit

Obesity is fast becoming one of North America's most serious health problems. Laval University is one of the world's premier laboratories for the study of obesity. Drs. Angelo Tremblay, Jean-Pierre Després and their colleagues in the department of Médecine sociale et préventive have made a number of important discoveries that are helping people struggling with obesity, as well as those just watching their weight. For example, they have found that if your meal includes both fatty food and alcohol, you are likely to overeat. The success of a fitness program depends greatly on the post-exercise meal-hint: it should be low in fat. While not safe for everybody, high-intensity interval training is more effective for losing fat than endurance training. The group also found that exercise is the best treatment for insulin resistance syndrome: a low-intensity exercise, such as a brisk one-hour walk, can substantially reduce the risk of diabetes and heart disease.

Test helps to preserve babies' vision

Poor vision doesn't necessarily reflect an eye problem; it could be a symptom of a problem in the brain, especially in the very young. Diagnosis begins with a test, but while testing vision in adults is straightforward, standard eye charts don't work on infants. Yet it is essential to discover a neurological problem early, because there are only a few years when brain cells can be permanently changed. Researchers at Memorial University are working towards early detection through the development of a contrast sensitivity test. Psychologist Dr. Russell Adams developed the eye test, which is a series of striped circles of varying contrasts. The child fixes his gaze on one of the circles, indicating that he has developed a pathway sensitive to that level of contrast. While the results are not definitive, they help the tester make an educated guess at where the problem lies, and will help researchers build more sophisticated diagnostic tests.

Less waiting means fewer frayed nerves

Road rage and air rage are new terms in our vocabulary. But these extraordinary phenomena are the end result of a very common experience: waiting. While incidents of road rage and air rage are still relatively rare, the consequences of waiting are serious, for example, when medical treatments or court cases are delayed. Associate Professor Myron Hlynka is a mathematician modelling queues to discover the critical point where road rage or air rage is likely to occur. He is an investigator in the University of Windsor's Queueing Theory Group. Some of the members of his team are developing a queueing model for medical conditions. The group hopes to develop queueing models to use in medical institutions and industrial procedures and eventually the court systems in Ontario, with the intention of making them more efficient for the public.

Computer games make learning math and science fun

Sharing isn't just a virtue – it's a great way to spur achievement and motivate young students working with computers. This is especially true for girls. That's one of the interesting results of multi-faceted research into the value of computer, video and other interactive games in the acquisition of math and sciences skills, conducted at the University of British Columbia's E-GEMS (Electronic Games for Education in Math and Science). This work has already yielded a mathematics adventure CD-ROM for ages 8-12 titled "Counting on Frank," developed by a Vancouver-based company. The project is directed by Maria Klawe, a computer scientist and Dean of Science at UBC. Her research has provided valuable insights into the design and use of educational computer games. As a result of this work, E-GEMS researchers are now in discussions with two leading companies developing computer games aimed at girls.

2.3.2 People

NSERC invested $206 million in 1999-2000 to train the next generation of science and engineering graduates. This training support is provided in two ways: (1) directly through national competitions to selected individuals; and (2) through indirect support provided by an NSERC-funded researcher from his or her NSERC grant.

NSERC must be able to support enough graduate students in the natural sciences and engineering to meet the needs of the country, and the support must be at a high enough level to attract the best people. Without these long-term investments in young people Canada will experience a decline in its ability to compete and innovate in a knowledge-based world.

For a more detailed analysis of the impact on Canada's economy of supporting advanced training in the NSE, see Section 6.6.

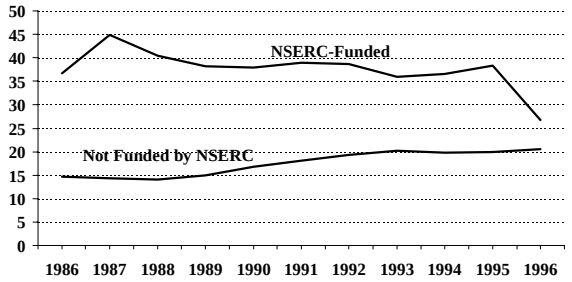
NSERC measures the impact of its training investments through four indicators:

1. Undergraduate Students Going On to Graduate School
2. Career Progression of Master's and Doctoral Students
3. Career Progression of Postdoctoral Fellows
4. Career Progression of Industrial Research Fellows

1. Undergraduate Students Going On to Graduate School

NSERC provides four-month jobs for undergraduate students in the natural sciences and engineering through our Undergraduate Student Research Awards (USRA) program (Note: NSERC-funded researchers also support undergraduate students through their NSERC research grants). NSERC's current annual investment of $13 million brings this experience to nearly 3,000 students every year. The program's objective is to stimulate the interest of undergraduate students in research by providing them with valuable experience in a university or industrial laboratory, and to encourage these students to undertake graduate studies.

Figure 23: Percentage of Undergraduate Students Who Go On to Graduate School (%)



Source: NSERC estimates.

More than 30% of USRA winners pursue graduate studies; we know this because this number goes on to hold NSERC postgraduate awards. In fact, many more USRA winners probably go on to graduate school

without direct NSERC support, but their numbers are unknown. However, reasonable estimates for this group and undergraduates that do not receive NSERC funding and that go on to graduate school can be made. Figure 23 indicates that NSERC-funded undergraduates are on average twice as likely to go on to graduate school as those not funded by NSERC. The dip in this ratio in 1996 was caused by less money available for the program and a temporary reduction in the number of awards made to large universities.

2. Career Progression of Master's and Doctoral Students

NSERC provides scholarship support for Canadians to pursue a master's or doctoral degree in the natural sciences and engineering. This is done in two ways: (1) directly through national programs supporting more than 3,200 students annually at a cost of $53 million per year; and (2) indirectly through NSERC's research grants, which support more than 4,500 students (full-time equivalent), at roughly $83 million per year.

The career status of former NSERC-funded master's and doctoral students and the degree to which NSERC funding affects their ability to undertake or continue with their studies are important indicators of the impact of the scholarship support. Over the past five years NSERC has completed annual surveys of directly funded master's and doctoral students. A total of 1,193 former NSERC-funded students have replied (a response rate of over 50%). Just under half (46%) of the respondents wrote remarks in the "Comments" section of the questionnaire. Most of the remarks were positive. (See side box).

NSERC-Funded Master's and Doctoral Students Comment on Their Awards

- "I now have tremendous research opportunities in my current job which I would not have had without my NSERC-funded training. The knowledge is beneficial to myself and employer certainly, but arguably for the country overall."
- "NSERC support was critical to my decision to pursue graduate studies instead of employment. I appreciate very much the opportunities now available to me as a result of your investment in me."
- "There are very few qualified Canadians available for hire in our industry. NSERC is a key enabler for generating suitable candidates, and thus plays a big role in our industry."

The major findings of these surveys can be summarized as follows:

- The unemployment rate for respondents is less than 2%.
- 83% of the respondents (employed or self-employed individuals in a full-time position in Canada) have an annual salary greater than $45,000.

2. Career Progression of Master's and Doctoral Students (Cont'd)

- A high percentage (65%) of respondents are active in a research and development capacity, using their training for one of the primary purposes of the scholarship programs.

- 70% of respondents feel that their graduate training was "critical" to their careers.

- 211 respondents (18% of the total) were living outside the country at the time of the survey. One-half of these respondents intend to return to Canada.

- 96% of the respondents completed the degree (master's or doctorate) for which they received NSERC funding.

- 90% of the respondents said that NSERC funding was moderately important to essential to undertake or continue with their studies.

3. Career Progression of Postdoctoral Fellows

After a doctoral degree it has become customary in certain fields to go through additional postdoctoral research training. NSERC directly funds postdoctoral fellows (PDFs) for up to two years to continue their research training. NSERC now invests approximately $13 million per year to support roughly 450 Canadian PDF's per year. NSERC also provides this PDF support for more than 800 other individuals through NSERC research grants.

Survey results from the first-ever survey of previously funded postdoctoral fellows are presented below. The survey is similar to the master's and doctoral students' surveys.

The career status of former NSERC-funded postdoctoral fellows and the degree to which NSERC funding affects their ability to undertake or continue with their research training are important indicators of the impact of the support. A total of 156 former NSERC-funded postdoctoral fellows replied (a response rate of 40%) to the first survey. A sample of some of the respondents' remarks in the "Comments" section of the questionnaire are presented in the side box.

NSERC-Funded Postdoctoral Fellows Comment on Their Awards

- "Without my NSERC support I would simply not have conducted a research career – it changed my life."
- "NSERC Postdoctoral fellowships are essential to ensure the brightest young people remain in the University setting to become faculty in our Universities. This is most important."
- "NSERC PDF's are vital to insure that our best students get the opportunity to continue their studies in the world's best laboratories. Excellent programme-Keep it up!!"

The major findings of the survey can be summarized as follows:

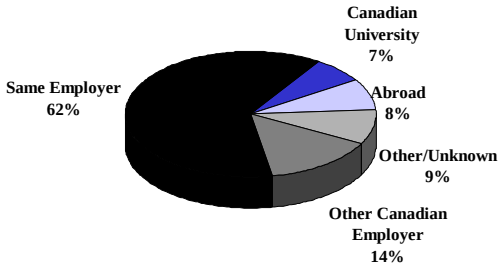
- The unemployment rate for respondents is less than 2%.
- 86% of the respondents (employed or self-employed individuals in a full-time position in Canada) have an annual salary greater than $45,000.
- A very high percentage (88%) of respondents are active in a research and development capacity, using their training for one of the primary purposes of the program.
- 78% of respondents feel that their postdoctoral training was "critical" to their careers.
- 47 respondents (30% of the total) were living outside the country at the time of the survey. One-quarter of these respondents intend to return to Canada.

4. Career Progression of Industrial Research Fellows

Another route for doctoral graduates to gain additional research experience is through NSERC's Industrial Research Fellowships (IRF) program. This relatively small program invests approximately $3 million per year to help place 160 Canadian Ph.D.s annually in industrial laboratories. This investment has contributed significantly to the number of doctoral graduates working in Canadian industrial labs. More than 15% of Canadian industrial researchers with a Ph.D. have been funded by NSERC through the IRF program.

To determine if the program is staying on track, NSERC routinely monitors the employment situation of former IRF winners. Ideally IRF winners would continue to work as industrial researchers. Figure 24 shows the current employer for the 887 Fellows who finished their award from 1980 to 1999. Seventy-six per cent of former IRF winners are still working in Canadian industries. A small percentage have gone on to academic positions in Canadian universities, and a similar percentage have left the country.

Figure 24: NSERC's Industrial Research Fellows: Where Are They Now?



Total: 887

Source: NSERC Industrial Research Fellows from 1980 to 1999.

NSERC also surveys representatives of the company where the Fellows worked, or their supervisors. Surveys from over 100 companies involving 340 Fellows have been received to date. The reaction of the companies responding to the survey has been overwhelmingly positive:

- 98% of the firms said that the program was able to meet their requirements;
- 98% stated that the research project undertaken by the Fellow was "successful," and 94% believed it to be cost-effective.

Some of the comments received from company representatives are highlighted in the side box.

Company Representatives Comment on NSERC Industrial Research Fellows

- "The IRF program provides the added financial leverage to permit successful competition for talented Canadian Ph.D.'s. It helps to keep these individuals in Canada. It helps the high tech company to expand its R&D base with a reduced training burden or risk."
- "NSERC`s IRF program offers small Canadian companies the possibility to participate in a variety of research projects. These projects carry a high risk and any return on the original investment is typically long delayed. For the majority of small companies any involvement in these kinds of projects without NSERC support could not be possible."
- "NSERC`s IRF program is a very successful program, providing a means for smaller companies to effectively build their internal R&D capability."

2.3.3 Service Delivery and Service Standards

NSERC is committed to improving the quality of its services and administrative efficiency by enhancing program delivery and improving access to information for all interested parties. Some of the service initiatives that have been completed or started in 1999-2000 include:

- NSERC and SSHRC, in consultation with the research community, have agreed to review all existing grant policies and procedures to harmonize their respective sets of directives, wherever possible.

- NSERC continues to increase public awareness of the natural sciences and engineering research sector. As part of its new Communications Policy, NSERC is reaching out to the general public and the business community, as well as maintaining its traditional contacts with researchers.

- NSERC continues to expand the availability of Web-based versions of all application forms for grants and scholarships. Specialized software isn't needed by the applicants, since everything can be downloaded free of charge from the Internet.

- The popular breakfast series for M.P.s and Senators in collaboration with the Partnership Group for Science and Engineering (PAGSE) continues with good attendance. These events are designed to bring research advances and issues to the attention of federal politicians.

- NSERC will continue to develop new ways of using web technology to provide better access to information for users of NSERC programs, as well as to increase the awareness of the value of NSERC-funded research among the public, opinion leaders and the private sector. NSERC launched a re-designed web site in the spring of 1999 to better serve its clients. This included a web-based searchable database (www.nserc.ca/programs/result/database.htm) to permit anyone to run queries on NSERC-funded research.

2.4 Resources

Figure 25 presents the resources devoted to NSERC's business line, Support of Research and Scholarship in the Natural Sciences and Engineering. Spending in 1999-2000 reached $550 million or 9 per cent of the federal government's expenditure on science and technology.

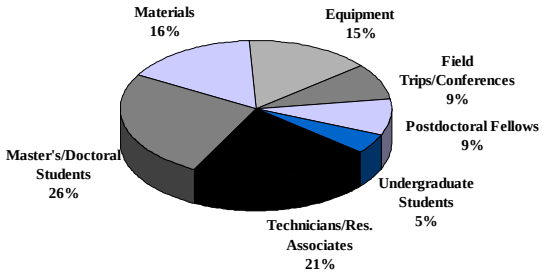
Figure 25: NSERC Expenditures, 1999-2000

Business Line	Support of Research and Scholarship in the Natural Sciences and in Engineering

Planned Spending	$538,500,000
Total Authorities	$550,126,185
1999-2000 Actuals	**$549,848,433**

The 1999-2000 spending for goods and services purchased by Canadian university researchers with NSERC grant funds, together with NSERC's direct scholarship spending, is presented in Figure 26. Over 60% of NSERC research and training funds in 1999-2000 were used to support technicians, undergraduate and postgraduate students, and postdoctoral fellows. This creates and sustains more than 18,000 high-technology jobs every year. Materials, scientific equipment, and travel expenses for field trips and conferences make up the other 39% of research and training expenditures. Spending on these goods and services indirectly creates or sustains roughly another 1,500 jobs per year. NSERC's administration expenses of $23 million (4% of total expenditures) brings the total for the year to $550 million. Additional financial information on NSERC program expenditures can be found in Section 6.5 and a description of eligible research costs that NSERC pays for can be found in Section 6.7.

Figure 26: NSERC Research and Training Expenditures, 1999-2000



Total: $527 Million

Source: NSERC estimate based on 1998-99 expenditures.

It should be noted that when a university researcher receives an NSERC grant, the funding cannot be used for the researcher's personal income. It can only be used for the direct costs of research under a strictly defined set of rules and accountability procedures.

3. Consolidating Reporting

3.1 Transfer Payments

Transfer payments of $527 million were made in 1999-2000 under one NSERC program, "Support of Research and Scholarship." As such, performance information for this program is presented in Section 2 of this report.

4. Financial Performance

4.1 Financial Performance Overview

Tables 1, 2, 3, 7, and 9 in the next section present the required financial information for NSERC, while the other Financial Tables were not applicable to NSERC. There were no major differences between planned and actual spending levels for 1999-2000.

4.2 Financial Summary Tables

The following tables represent the required financial information for NSERC.

Table 1: Summary of Voted Appropriations

Financial Requirements by Authority (millions of dollars)

		1999-2000		
Vote		**Planned Spending**	**Total Authorities**	**Actual**
	Natural Sciences and Engineering Research Council Program			
85	Operating expenditures	18.3	21.0	**20.7**
90	Grants	518.3	526.9	**526.9**
(S)	Contributions to employee benefit plans	1.9	2.2	**2.2**
	Total Program	*538.5*	*550.1*	***549.8***
	Total Agency	**538.5**	**550.1**	**549.8**

Note: Total Authorities are Main Estimates plus Supplementary Estimates plus other authorities.
Due to rounding, figures may not add to totals shown.

Planned spending includes:

- additional funding of $1 million per year to establish a Network of NSERC Industry Chairs in Design Engineering
- additional funding announced in the 1999 federal budget of $32.5 million per year ($25 million to support advanced research plus $7.5 million targeted for health-related research).

Table 2: Comparison of Total Planned Spending to Actual Spending

NSERC Planned versus Actual Spending (millions of dollars)

Support of Research and Scholarship	1999-2000 Planned Spending	1999-2000 Total Authorities	1999-2000 Actual
FTEs	215	215	222
Operating[1]	20.2	23.2	22.9
Capital	—	—	—
Voted Grants & Contributions	518.3	526.9	526.9
Subtotal: Gross Voted Expenditures	538.5	550.1	549.8
Statutory Grants and Contributions	—	—	—
Total Gross Expenditures	**538.5**	**550.1**	**549.8**
Less:			
Respendable Revenues[2]	—	—	—
Total Net Expenditures	**538.5**	**550.1**	**549.8**
Other Revenues and Expenditures			
Non-Respendable Revenues[3]	(0.4)	(0.3)	(0.3)
Cost of Services Provided by Other Departments	1.7	2.0	2.0
Total Transfer Payments	**539.8**	**551.8**	**551.6**

1. Operating includes contributions to employee benefit plans.
2. These revenues were formerly called "Revenues Credited to the Vote."
3. These revenues were formerly called "Revenues Credited to the (CRF)."

Note: Total Authorities are Main Estimates plus Supplementary Estimates plus other authorities.

Table 3: Historical Comparison of Total Planned to Actual Spending

Historical Comparison of NSERC Planned versus Actual Spending (millions of dollars)

	Actual 1997-98	Actual 1998-99	1999-2000 Planned Spending	1999-2000 Total Authorities	1999-2000 Actual
Natural Sciences and Engineering Research Council	435.4	498.5	538.5	550.1	**549.8**
Total	**435.4**	**498.5**	**538.5**	**550.1**	**549.8**

Note: Total Authorities are Main Estimates plus Supplementary Estimates plus other authorities.

Table 4: Non-Respendable Revenues[1]

Non-Respendable Revenues (thousands of dollars)

	Actual 1997-98	Actual 1998-99	1999-2000 Planned Revenues	1999-2000 Total Authorities	1999-2000 Actual
Natural Sciences and Engineering Research Council	386	115	400	313	**313**
Total Non-Respendable Revenues	**386**	**115**	**400**	**313**	**313**

1. These revenues were formerly called "Revenues Credited to the (CRF)."

Table 5: Transfer Payments

Transfer Payments (millions of dollars)

Support of Research and Scholarship	Actual 1997-98	Actual 1998-99	1999-2000 Planned Spending	1999-2000 Total Authorities	1999-2000 Actual
Grants	418.0	478.0	518.3	526.9	**526.9**
Contributions	—	—	—	—	**—**
Total Transfer Payments	**418.0**	**478.0**	**518.3**	**526.9**	**526.9**

Note: Total Authorities are Main Estimates plus Supplementary Estimates.

5. Departmental Overview

5.1 Mandate, Vision, and Mission

Mandate

Created in 1978, NSERC's legal mandate, its functions, and its powers are defined as follows:

> "*It is the function of the Council to (a) promote and assist research in the natural sciences and engineering other than the health sciences; and (b) advise the Minister in respect of such matters relating to such research as the Minister may refer to the Council for its consideration*" *(Natural Sciences and Engineering Research Council Act 1976-77, c24).*

A Vision for NSERC

During the process of a year-long review of NSERC's strategic directions, NSERC Council believed it was important to spell out a vision for NSERC.

> *NSERC is working to build a "Smart Canada" for the 21st century – a country that's safe, clean and prosperous.*
>
> *We see our people working at rewarding and meaningful jobs because they have the skills and knowledge to create value and meet needs in the global economy.*
>
> *We see our scientists and engineers respected throughout the world because of their leading-edge discoveries and trailblazing projects.*
>
> *We see our industries thriving because business is taking full advantage of the nation's capacity for science-based innovation.*
>
> *And we see NSERC playing, and seen to be playing, a leading role in making all this happen…by investing in people, discovery and innovation.*

Restating NSERC's Mission

During the review, Council also restated its mission in terms that draw more clearly the connections between research and the well-being of Canadians in order to continue to build support for world-class university research and training.

> *NSERC invests in people, discovery, and innovation to build a strong Canadian economy and to improve the quality of life of all Canadians. It supports research in universities and colleges, research training of scientists and engineers, and research-based innovation.*
>
> *The Council promotes excellence in intellectual creativity in both the generation and use of new knowledge, and it works to provide the largest possible number of Canadians with leading-edge knowledge and skills to help Canada flourish in the 21st century.*
>
> *NSERC fulfils its mission by awarding scholarships and research grants through peer-reviewed competition, and by building partnerships among universities, colleges, governments and the private sector.*
>
> *NSERC itself is committed to institutional innovation in achieving its mission.*

5.2 NSERC Operations

NSERC operates within a framework of:

(1) programs developed in consultation with the Canadian research community, in the context of the present and future challenges facing the Canadian university research system, and in light of Canada's needs and government priorities; and

(2) a rigorous process of peer review for awarding funding within the programs.

The peer review system ensures that funds go only to the best researchers and students, and the best research programs and projects. NSERC's involvement guarantees objective and fair review of applications for support. A more detailed description of the peer review process for research grants can be found in Section 6.8.

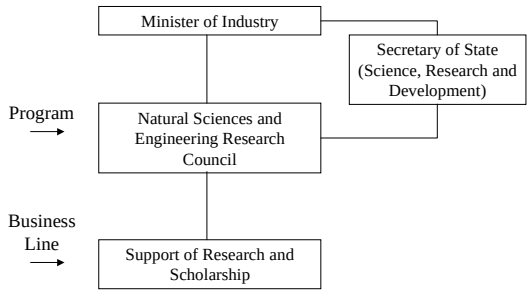
Applications for research funding are judged first and foremost on the merits of the proposed research and on the excellence of the research team; other criteria vary among the Council's programs, and include the level of commitment from industrial partners, the plans for interacting with the partners, and (especially for large projects) the design of the project and the proposed management structure.

Applications for direct student support, through NSERC's Scholarships and Fellowships programs, are judged on the student's academic qualifications, as well as his or her potential for research achievement, and an assessment of his or her leadership qualities. NSERC recognizes that success in graduate studies, and in a subsequent research career, is dependent on more than academic excellence; an enquiring mind, adaptability, and the ability to work well in a team are also essential. In addition, many other students receive NSERC support indirectly, through research grants awarded to their faculty supervisors.

5.3 Departmental Organization

NSERC's sole business line is: Support of Research and Scholarship in the Natural Sciences and in Engineering. Figure 27 presents NSERC's organization structure.

Figure 27: Organization Structure



NSERC is governed by a Council (a Board of Directors) whose members are drawn from industry and the universities, as well as from the private non-profit sector, and appointed by the Governor-in-Council. Members serve part-time, and receive no remuneration for their participation. The President serves full-time, and functions as the Chair of the Board and the Chief Executive Officer of the Council. Council is advised on policy and programming matters by several committees. Figure 28 presents NSERC's committee structure.

Figure 28: Council Committee Structure

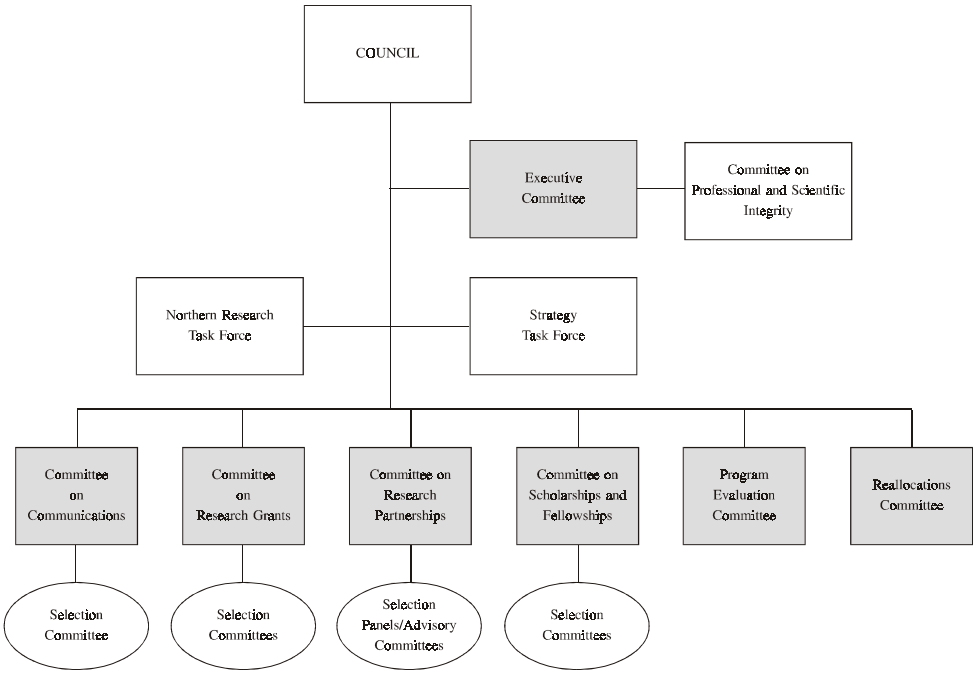
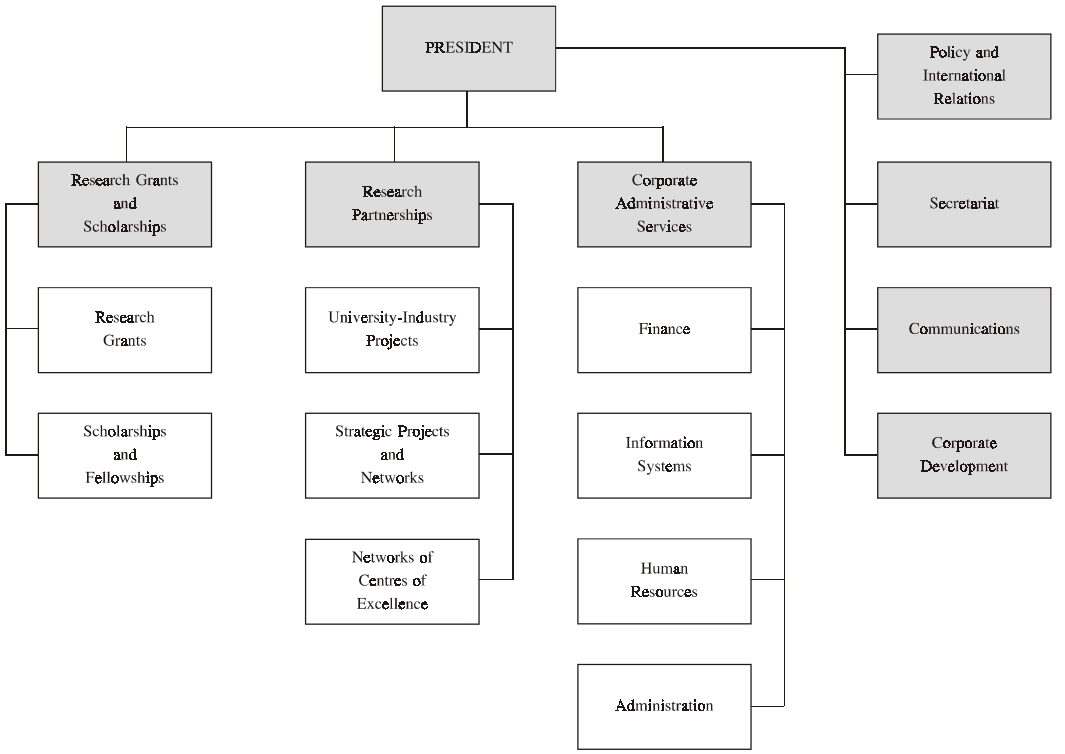


Figure 29 displays the corporate structure. NSERC is organized around two program directorates - Research Grants and Scholarships, and Research Partnerships. The Directors General of these directorates report directly to the President. There are also four corporate functions: Policy and International Relations, Corporate Development, Communications, and the Secretariat; the Directors of these units also report to the President. Finally, there is the Corporate Administrative Services Directorate. This directorate is shared with the Social Sciences and Humanities Research Council (SSHRC), and handles Human Resources, Information Systems, Finance, and Administration for both Councils. Its Director General reports to the Presidents of both SSHRC and NSERC.

Figure 29: Corporate Structure



6. Other Information

6.1 Contacts for Further Information and Web Sites

Our Web site is located at: www.nserc.ca

For further information about this report you can contact:

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6.2 Legislation Administered and Associated Regulations

NSERC does not administer any legislation.

NSERC was created by the *Natural Sciences and Engineering Research Council Act 1976-77, c. 24, s. 24*.

6.3 Other Departmental Reports

Copies of the following reports are available:

- Annual Report 1998-99
- Annual Report 1997-98, Networks of Centres of Excellence
- NSERC Facts and Figures 1998-99
- Postgraduate Surveys
- Longer-Term Performance Indicators for the Collaborative Research Development Program
- Performance Indicators for the Research Grants Program
- Report on Plans and Priorities 2000-2001

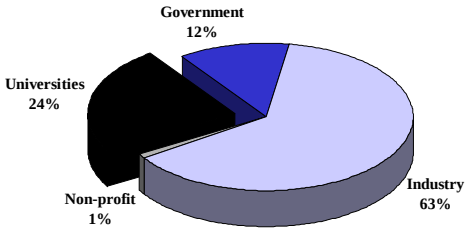
6.4 University Research in Canada

(Refer to Section 2.1)

The following statistics are presented to help the reader understand the position and relevance of Canadian university research.

1. University researchers conducted 24% of all Canadian research, as measured by expenditures, in 1999 (see Figure 30).
2. Of the $3 billion of direct and indirect investment in Canadian university research in 1999, 38% was allocated to the natural sciences and engineering (see Figure 31).
3. Figure 32 shows trends in the funding of Canadian university research in the NSE. Over the past three years the Federal government's share has increased.
4. Canadian university researchers perform 3% of the nearly $100 billion in university research in the OECD (see Figure 33). When measured as a percentage of gross domestic product, Canada conducts roughly the same amount of university research as most of its G7 competitors.

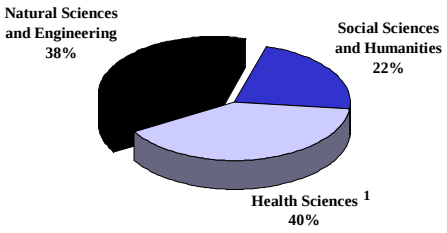
Figure 30: R&D Performance in Canada, 1999



Total: $14.9 Billion

Source: Statistics Canada

Figure 31: University R&D in Canada by Discipline, 1999

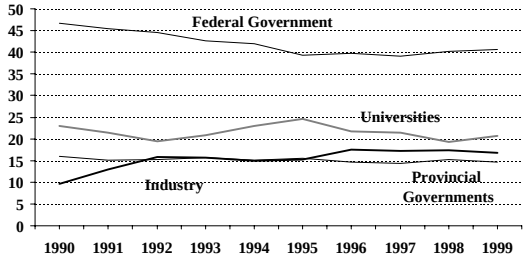


Total: $3.5 Billion

1. Includes hospitals.

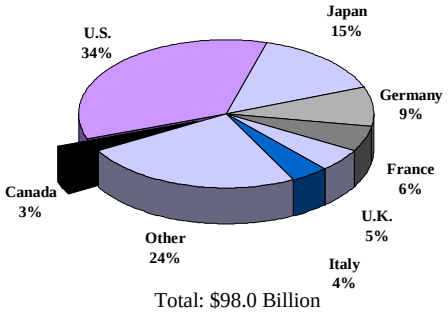
Source: Statistics Canada, NSERC estimate.

Figure 32: Canadian University R&D Funding in the Natural Sciences and Engineering (%)



Source: Statistics Canada, NSERC estimate.

Figure 33: University R&D Expenditures in the OECD, 1997



Total: $98.0 Billion

Source: OECD

6.5 Supplementary Tables

Table 6: "Spin-Off" Companies Linked to NSERC-Funded Research by Province

Province	Number of Companies	Number of Employees	Annual Sales/ Revenue (millions of $)
British Columbia	23	2,370	279
Alberta	10	619	72
Saskatchewan	7	698	93
Manitoba	2	6	0.2
Ontario	39	2,540	466
Quebec	18	920	341
New Brunswick	2	98	13
Nova Scotia	7	244	29
Newfoundland	3	47	6
TOTAL	111	7,542	1,299

Source: NSERC

Table 7: NSERC Expenditures (thousands of dollars)

	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
People (Direct Support)	79,413	86,547	94,591	93,202	88,686	82,323	67,944	69,080	79,840	96,341
Discovery	252,908	264,626	271,317	267,906	277,237	263,130	265,605	243,969	286,237	307,562
Innovation	106,743	104,978	107,366	106,577	101,078	104,952	99,600	102,789	110,900	121,649
General Support	9,768	9,670	9,414	9,040	7,994	1,450	1,588	2,209	1,009	1,343
GRANTS AND SCHOLARSHIPS	448,832	465,820	482,688	476,725	474,995	451,856	434,737	418,048	477,986	526,896
Administration	17,410	16,292	16,560	18,138	17,613	17,019	16,905	17,464	20,506	22,952
TOTAL EXPENDITURES	466,242	482,112	499,248	494,863	492,608	468,875	451,642	435,512	498,492	549,848

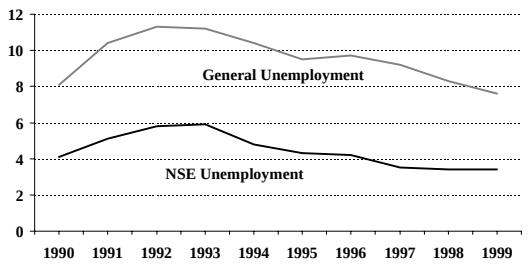
6.6 Analysis of Impact of Training Support

(Refer to Section 2.3.2)

Why does NSERC invest in training Canadians in the NSE? There are many reasons, but four will be highlighted with some independent data to support the conclusions:

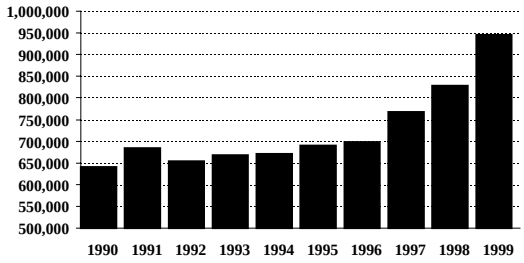
1. The demand for such people is high, as indicated by a very low unemployment rate for Canadians in the natural sciences and engineering, less than one-half the rate for the general population (see Figure 34).
2. Employment growth for natural scientists and engineers is strong (see Figure 35) and one of the highest of all occupation groups.
3. Unemployment levels fall and earnings increase as university graduates in the NSE earn higher degrees, NSERC's major training focus (see Figure 36).
4. Canada needs more research scientists and engineers to compete with the highly industrialized nations of the world (see Figure 37).

Figure 34: Unemployment Rate for Natural Scientists and Engineers (%)



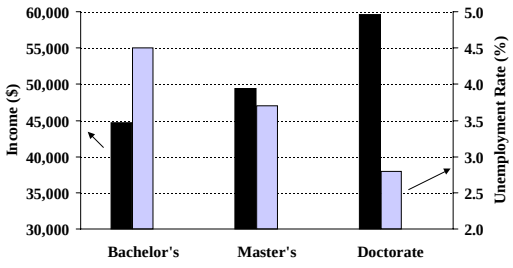
Source: Statistics Canada

Figure 35: Number of Natural Scientists and Engineers Working in Canada



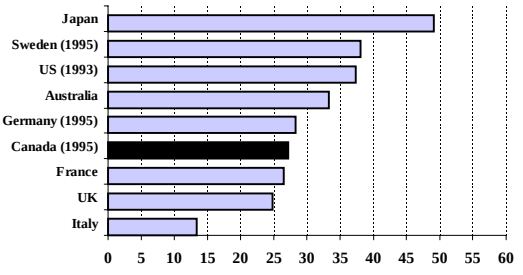
Source: Statistics Canada

Figure 36: Income and Unemployment Levels by Degree Level for Graduates in the NSE, 1995



Source: Statistics Canada

Figure 37: Scientists and Engineers Engaged in R&D per 10,000 Population, 1996



Source: OECD

6.7 Direct/Indirect Costs of Research

(Refer to Section 2.4)

Direct Costs

The direct costs of research that NSERC grants pay for include, but are not limited to:

- salaries of postdoctoral fellows, specialized technicians dedicated to the research, research associates providing expertise at a higher level, visiting scholars from abroad, and some undergraduate students, particularly in the smaller institutions;
- operating costs of purchased research equipment, including their maintenance, repair, and upgrading;
- consumable supplies needed for the research;
- computer time on central facilities, communication costs;
- access to major external research maintained with pooled resources;
- user fees for services and access to facilities in the universities and government labs, and the purchase of services and supporting infrastructure;
- the design, construction, and operation of custom-made experimental apparatus;
- the purchase of certain instruments and research;
- logistic costs of all field research;
- the cost of travel to laboratories, facilities and conferences within Canada and abroad, and publication costs;
- the cost of environmental assessment of any projects that could have an impact on the environment.

Indirect Costs

The indirect costs of university research, sometimes also called research overheads, are the costs to the university of being in the business of research. These are the costs to the university of providing institutional support for research in the areas in which the university has chosen to be active. Here are examples of specific indirect costs of research that illustrate the range of support expected of the universities:

- library collections of current journals and monographs;
- communications and information technology infrastructure;
- laboratory space, provided with heat, power, light, and maintenance and cleaning services;
- technical staff;
- accommodation for postgraduate students and research staff;
- office space for the Principal Investigator (PI);
- central facilities such as an electronics shop, machine shop, glass-blowing shop;
- a specialized capacity in the purchasing department for the acquisition of research equipment;
- animal holding facilities meeting the standards required by the CCAC;
- a capacity for research administration e;g;, accounting, reporting, negotiating partnerships, preparing applications for research funding, etc.;
- a capacity to help PIs with technical, financial and legal issues related to the commercialization of research results that have the potential to lead to innovations in the market – including appropriate policies on IP disclosure, ownership, etc.;
- an institutional capacity to set up and support Research Ethics Boards and implement the Tri-Council Policy Statement on ethics in research involving human subjects;
- an institutional capacity for environmental assessment of all research projects that might have an impact on the environment;
- an institutional capacity for monitoring and providing training on animal care and facility standards.

6.8 Peer Review Explained

(Refer to Section 5.2)

Peer review is the assessment of research proposals or research contributions by impartial experts in the specific field. It is generally recognized as the best system available to perform such assessments - for example, the emerging economies in Eastern and Central Europe are establishing peer review systems based on principles similar to those in use in the U.S. and Canada.

NSERC's peer review process generally works as follows, with some variation from program to program:

1. An eligible faculty member submits an application for funding for a research project or program. The application includes information on:
   - the proposed research (proposed course of work, theoretical underpinnings, methodology, references to previous work, anticipated results, etc.)
   - the researcher or research team (training, qualifications, previous contributions to the field, etc.);
   - an itemized budget for the project or program;
   - details of other funding previously or currently held by the researcher or the team;
   - for the Research Partnerships program, an outline of the contribution to be made to the project from partners outside the university sector, and a plan for transferring the results of the research to the user sector;
   - for very large projects, a description of the management structure for the project.
2. The application is sent out for review by international experts in the field - typically three to five experts are consulted per application. Experts from all sectors, within and outside Canada, may be consulted.
3. The application and all reviews received are sent to a selection committee composed of experts who have agreed to donate their services. This committee evaluates each application in the context of all applications sent to it at the same time.
4. The committee evaluates the application against the program criteria - these always include the quality of the proposed work and the qualifications and track record of the applicant(s); they may include additional criteria, depending on the program under which the application is made.
5. The selection committee recommends whether or not the application should be funded, and if funded, the size and duration of the grant.
6. If the application is unsuccessful, the committee provides brief notes to the applicant outlining the reasons for its decision.

7. Reader's Survey

NSERC would like to hear from Canadians who have read this report. Your comments will help ensure that NSERC provides information that is easy to understand and relevant. NSERC would appreciate it if you would take the time to answer the questions below and send in your completed questionnaire as soon as possible. Please use the scale provided and select the number that best represents your point of view.

	Not at All			Somewhat			To a Great Extent
1. Did the report explain clearly what NSERC does?	1	2	3	4	5	6	7
2. Did the report provide you with sufficient information to assess whether Canadians are receiving value for the money invested in NSERC?	1	2	3	4	5	6	7
3. Has the report presented accomplishments and performance information in a balanced manner (e.g., presented both positive and negative aspects)?	1	2	3	4	5	6	7
4. Overall, was the information presented in this report easy to understand?	1	2	3	4	5	6	7

Are there any additional comments you would like to make regarding this report?

Send your completed questionnaire:

By mail to
Policy and International Relations
NSERC
350 Albert Street
Ottawa, Ontario
K1A 1H5

Or by fax to
(613) 947-5645

Or by e-mail to
bjl@nserc.ca

Thank you for your co-operation.