ESTIMATES

Natural Sciences and Engineering Research Council of Canada

Performance Report

For the period ending
March 31, 1998

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 what was known as the annual *Part III of the Estimates* document for each department or agency into two documents, a *Report on Plans and Priorities* and a *Departmental Performance Report.*

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.

This year, the Fall Performance Package is comprised of 80 Departmental Performance Reports and the government's "*Managing For Results*" report.

This ***Departmental Performance Report,*** covering the period ending March 31, 1998, 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 *Part III of the Main Estimates* or pilot *Report on Plans and Priorities* for 1997-98. The key result commitments for all departments and agencies are also included in *Managing for Results.*

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 and develop both managing for and reporting of results. 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/tb/key.html

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Departmental Performance Report

for the period ending March 31, 1998

NSERC

(Natural Sciences and Engineering Research Council of Canada)

Serving Canadians for

Years

_____

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 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, the environment, public education, and our 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, is funded directly by Parliament, and reports to it through the Minister of Industry.

What we do

Our mission is to foster the discovery and application of knowledge through the support of university research and the training of scientists and engineers. The Council promotes the use of this knowledge to build a strong national economy and 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. Canadian university researchers, often in partnership with industry, gain access to leading-edge knowledge from around the world to help fuel Canada's innovation system. 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 (See Figure 1.)

Some of our accomplishments

In recent years, NSERC has been successful in:

- maintaining a strong presence in world science and engineering research by supporting nearly 8,800 of the most creative and productive Canadian researchers;
- training nearly 50,000 master's and doctoral students, and young research professionals since 1978, who have had little trouble finding well-paying 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 $450 million since 1978 in university research and training activities.

Figure 1: 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 3.4.2
	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 3.4.1
.	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	performance indicators to be developed
	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 3.4.1
	➢ economic impact of NSERC-supported research	DPR Section 3.4.1

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List of Abbreviations

AUCC	Association of Universities and Colleges of Canada
CFI	Canada Foundation for Innovation
CRD	Collaborative Research and Development Grant
CRF	Consolidated Revenue Fund
DPR	Departmental Performance Report
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	Organization for Economic Co-Operation and Development
P	Preliminary
R&D	Research and Development
S&T	Science and Technology
SSHRC	Social Sciences and Humanities Research Council of Canada
USRA	Undergraduate Student Research Award

1. Messages

1.1 Message from the Minister of Industry

Canada is well positioned to be a leader in the new emerging global knowledge-based economy. Our government is working with the private sector to address the challenges in making the transition to this economy. By focussing on the challenges of a competitive 21st century economy, we can turn Canada's potential into reality and create jobs and wealth for our citizens. The Industry Portfolio, bringing together 13 departments and agencies with complementary goals and objectives, plays an important role in helping Canadians achieve this vision.

In 1997-98, the Industry Portfolio focussed on three areas of activity - each crucial for our economic success - now and into the next century:

- promoting innovation through science and technology;
- assisting businesses to grow by providing information, advice and financing support; and
- ensuring a fair, efficient and competitive market place.

The Portfolio members' Performance Reports collectively illustrate how the Portfolio is making a contribution toward the realization of these objectives.

The 13 Industry Portfolio members are ...

Atlantic Canada Opportunities Agency
Business Development Bank of Canada*
Canadian Space Agency
Competition Tribunal
Copyright Board
Canada Economic Development for Quebec Regions
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*

I am pleased to present the *Performance Report* for NSERC for the fiscal year ending March 31, 1998. In the *1997-98 Estimates Part III*, NSERC articulated its strategic objectives and described how its plans for the fiscal year would contribute to their realization. This report sets out NSERC's accomplishments against those plans and shows the contribution NSERC is making to Portfolio and government-wide objectives.

The Honourable John Manley

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

Canada's future is being built on a resource that is virtually limitless: *knowledge*. In a competitive global economy, all Canadians must be able to use knowledge to their best advantage. Competence in science, technology and innovation is an essential ingredient for success in the knowledge-based society.

Almost half of Canada's GDP growth is in the knowledge-intensive sectors of the economy. The fastest growing sectors include information and communications technology, aerospace, and consulting engineering. Canada's science and technology challenges, then, are to ensure that our people have the skills to benefit from the knowledge-based economy, and are able to innovate through science and technology in all aspects of our industrial growth. NSERC plays an essential part in doing just that - helping Canadians and businesses meet the challenges.

As Secretary of State for Science, Research and Development, I have taken a personal interest in the government's promotion of a culture where we use innovation and turn it into a competitive advantage in the marketplace. We need to keep the best and brightest minds in Canada, and we need to attract others from around the world. We need to build support for international partnerships that help build on the foundation of Canada's knowledge-based economy. As we enter the next century, the challenge will be to build on our momentum and ensure that Canada has the science and technology necessary to secure our place in the world for the next generation.

The Honourable Ron J. Duhamel

2. Departmental Overview

2.1 Mandate, Mission, and Objective

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, is funded directly by Parliament, and reports to Parliament through the Minister of Industry.

Mandate

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

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

Mission

In an effort to clearly define NSERC's purpose and the means by which its ends are achieved, in January 1994, the Council adopted the following mission statement:

> *The Natural Sciences and Engineering Research Council fosters the discovery and application of knowledge through the support of university research and the training of scientists and engineers. The Council promotes the use of this knowledge to build a strong national economy and quality of life for all Canadians. NSERC fulfils its mission by awarding grants and scholarships through a competitive process and by building partnerships among the universities, governments, and the private sector.*

As stated in the above mission statement, NSERC focuses on the university sector. Universities play a vital role in the creation of new knowledge and in putting this new knowledge to productive use, as well as in providing young people with the skills to contribute to these essential activities.

The federal science and technology strategy, *Science and Technology for the New Century* (March 1996), commits the federal government to three related goals for building a dynamic Canadian innovation system: sustainable job creation and economic

growth; improved quality of life; and advancement of knowledge. NSERC is committed to these goals and to working towards them as laid out in the Industry Portfolio's Action Plan.

Objective

The Council's ultimate objective is to advance Canada's prosperity and high quality of life by supporting the creation 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 that meets the highest international standards of excellence and it supports the education of young people in that research.

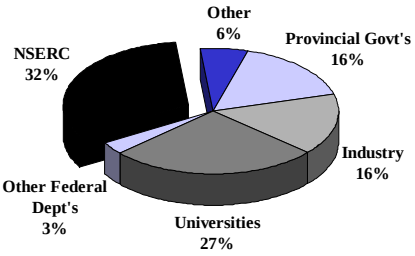
As a result, Canada has access to leading-edge science and technology from around the world and highly qualified people expert in it. Partnerships with industry connect researchers with those who can use the new knowledge productively and enhance Canada's capacity for innovation. Innovation contributes 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.

2.2 Market Position and Clients

Universities

NSERC is the single most important funder of research and development (R&D) in the natural sciences and engineering in Canadian universities. $1.1 billion in R&D was carried out by Canadian universities in the natural sciences and engineering in 1997. NSERC directly provided nearly one-third of the total funding. Since much of the other funding from universities, industries and governments is contingent upon NSERC funding, a reasonable estimate makes the Council directly and indirectly responsible for slightly more than half of the funding. Figure 2 gives a breakdown of the total funding by direct source. (See Section 5.4 for more statistics on Canadian university research.)

Figure 2: University R&D Funding in the Natural Sciences and Engineering, 1997



Total: $1.1 Billion

Source: Statistics Canada

Nearly 8,800 university researchers and over 9,000 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 3 presents the details of NSERC's client support. Estimates of the market share for eligible individuals and organizations and trends over the past ten years are also included.

Figure 3: NSERC's Clients, 1997-98

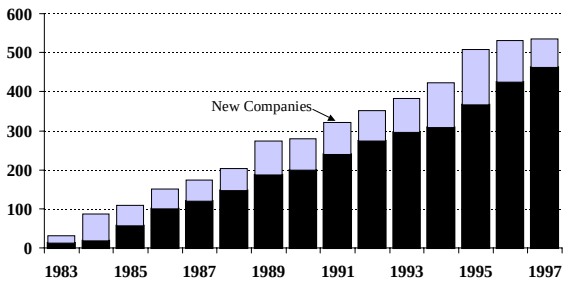
Canadian Clients	Number Supported or Participating	Market Share	Trends in Market Share Over Past 10 Years
Individuals:			
University Researchers	8,774	60% – 65%	Small Increase
Undergraduate Students	658	1%	Peaked at 4%
Master's/Doctoral Students	7,188	35% - 40%	Stable
Postdoctoral Fellows	1,500	40% - 50%	Stable
University Technicians	2,775	30% - 40%	Stable
Organizations:			
Universities	59	75%	Stable
Companies Performing R&D	719	9% - 11%	More than doubled
Federal Science Departments	11	65%	More than doubled
Provincial Science Departments	8	25% - 40%	More than doubled

Source: NSERC

Companies

Strong growth has taken place in the number of companies that have contributed to NSERC's collaborative university-industry research programs (see Figure 4). Since the inception of the university-industry research programs more than 1,200 firms have participated, rising from less than 50 companies in 1983 to more than 500 businesses in 1997. On average, 100 new firms are working with NSERC every year.

Figure 4: Number of Companies Contributing to NSERC's University-Industry Programs



Source: NSERC

NSERC is well known to companies heavily involved in R&D. Forty-three of the top 50 Canadian R&D companies (as ranked by the Globe & Mail, 1997) have funded university research jointly with NSERC.

2.3 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 5.6.

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 relevance to a program's goals, 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 simple 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.

2.4 Priorities and Challenges

Priorities

NSERC must be strategic in its investments to ensure that Canada's research enterprise continues to flourish, and that NSERC's actions are in line with Canada's needs and government policy, including the Science and Technology (S&T) Strategy and the Industry Portfolio's Action Plan. Therefore, NSERC resources are concentrated on the core functions of support for research and support for the training of highly qualified people. NSERC's investment priorities include:

1. Supporting basic research

The federal S&T Strategy outlines the need to build a strong Canadian innovation system. A key to achieving this is through the advancement of knowledge. Basic university research has been and will continue to be the primary source of excellent high quality new knowledge. Basic research is the starting point of applied research and commercialization. It is the source of new knowledge and tools that, when adopted in industry, can lead to product and processes innovations, creating economic activity benefiting future generations of Canadians. Therefore, the commitment to basic university research is central to NSERC.

2. Building partnerships

Core funding to support basic research only satisfies one need – the production of knowledge. NSERC's complementary objective – the productive use of knowledge – must also be achieved. To ensure that the stock of knowledge generated by university research is used to the benefit of all Canadians, NSERC must continue to foster the transfer of this knowledge to industry and other sectors – leading to new wealth creation, good jobs, entrepreneurial businesses and improved quality of life. Partnership between NSERC and other sectors, including government departments and agencies, is a key strategy to successful investments in Canada's capabilities in S&T.

3. Ensuring a supply of highly skilled scientists and engineers for Canada

NSERC's investment in the training and development of highly qualified people in science and technology is critical to Canada's long-term economic development and quality of life. Canada's future capabilities in science and technology and our future prosperity will depend on today's graduate students, postdoctoral fellows and junior faculty.

4. Striving for improved quality of service

NSERC has been able to offer a high quality of service to internal and external clients while maintaining a low ratio of administration to program funding – administration represents approximately 3.9% of total funding. Additionally, performance baselines and service standards are being developed to ensure the high quality of service is maintained.

Challenges

New challenges have arisen from the interdependent pressures on the Canadian university research system, government and industry, within the global economy. These include:

1. The demand for highly skilled people

Reports by many Canadian firms indicate that they cannot fill their need for highly skilled individuals in some fields, notably engineering and computer science. If this trend continues, we may see such companies, integral to Canada's economic survival, moving elsewhere to ensure a sufficient supply of highly qualified people. Therefore, young Canadians must be encouraged to pursue an advanced education in science and technology. However, with increased university tuition and unprecedented debt loads after graduation, graduate studies (with their high foregone earnings) are increasingly becoming a less attractive option for some of the best-qualified people.

2. The rising cost of doing research

Researchers and universities are increasingly challenged by the rise in the overall cost of conducting research. Maintaining leading-edge laboratories equipped to use new research methods, purchasing scientific instrumentation, keeping pace with computer technology and financing the logistics of field work are all examples of costly but essential components of successful research. University researchers must now pay user fees or commercial rates for some services and facilities that were once available free of charge. Fiscal restraint continues at all levels of government. The net effect has been that the funds provided by NSERC must meet growing expenses.

3. The need to encourage industry/university partnerships

Canadian companies are realizing the need to invest R&D both for short-term competitiveness and for long-term growth. Industry is recognizing the knowledge base the university community offers and is entering into partnerships with universities at an ever-increasing rate. It should be noted that NSERC is the principal source of public support for research partnerships between universities and the private sector. It has taken

the better part of two decades to bring the university and industry cultures together in this way, and now the effort is bearing fruit in spectacular fashion. There are many successful partnerships, and their achievements are creating wealth and high-quality jobs, and the demand for new partnerships is growing. The challenge is to continue promoting partnerships and to learn how to solve the inevitable problems, particularly in the area of intellectual property.

4. The need to break down disciplinary walls

Traditionally, research was an individual effort. While much excellent individual research still takes place, collaboration and teamwork have become more and more important. Groups of researchers with diverse disciplinary backgrounds and skill sets are working together, often in collaboration with industries and governments, to solve small- and large-scale problems to the benefit of society. Partly as a result of information technology, barriers between disciplines, institutions, sectors and nations are being broken down through networking and sharing research results and expertise. NSERC has participated in this evolution by developing programs and review mechanisms supporting multi-disciplinary research, but the recent Reallocations exercise shows that much remains to be done to break down the isolation of disciplines.

5. The impact of the Canada Foundation for Innovation

The federal investment of $800 million for the creation of the Canada Foundation for Innovation (CFI), announced in the February 1997 federal budget, was welcome news. The total investment by the CFI and its partners in the research infrastructure of Canada's universities, colleges and research hospitals should exceed $2 billion. However, while the CFI represents a significant opportunity to strengthen Canada's university research infrastructure, it will create challenges for all sectors. The granting councils, which fund the direct costs of research, have been told by researchers to expect an increase in demand for funding to operate the modernized facilities and laboratories

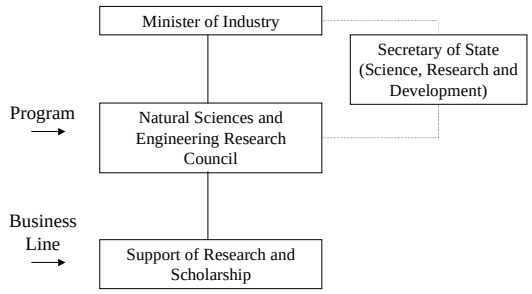
6. The loss of critical mass at universities

Canada faces an issue of losing highly qualified faculty at universities. As highly paid senior professors retire or relocate, often outside Canada, universities have tended to replace them with junior faculty, if at all. The Association of Universities and Colleges of Canada (AUCC), in collaboration with NSERC, surveyed almost 100 deans in four major fields (computer sciences, engineering, mathematics, and the physical and biological sciences) in 1997. The survey revealed that in 1995-96 and 1996-97, only about half of the departing faculty were being replaced. Of those replaced, over 80% were replaced at the entry level, even though departures were mostly at the senior or mid-career levels. The net effect is a loss of research capability at our universities, at least in the short-term.

2.5 Departmental Organization

NSERC's sole business line is: Support of Research and Scholarship in the Natural Sciences and in Engineering. Figure 5 presents NSERC's organization structure.

Figure 5: 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 6 presents NSERC's committee structure

Figure 6: Committee Structure

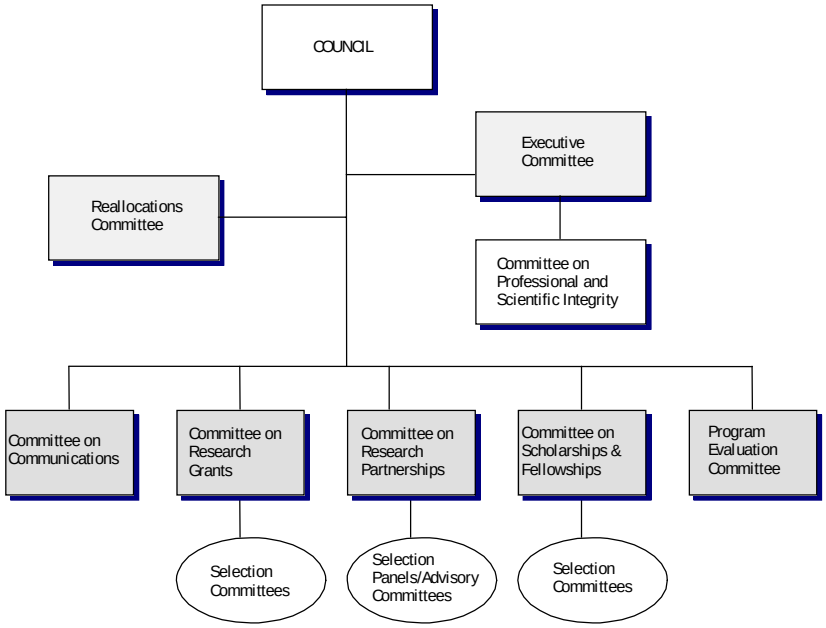
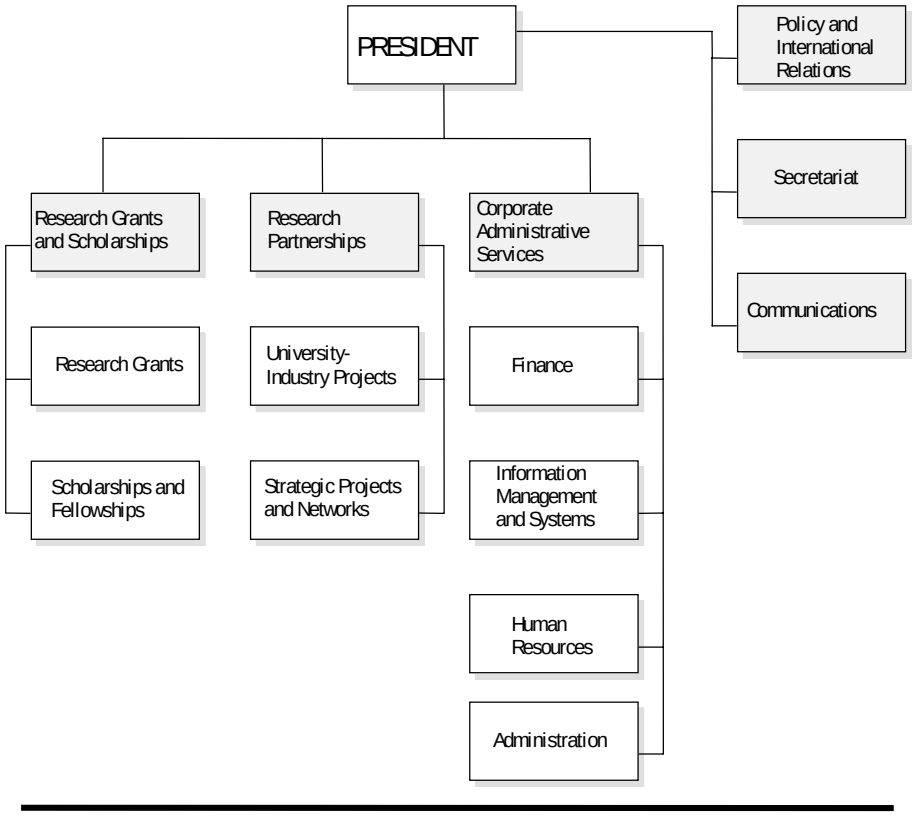


Figure 7 displays the corporate structure. NSERC is organized around two program directorates - Research Grants and Scholarships, and Research Partnerships. The Directors General of these directorates report directly to the President. There are also three corporate functions: Policy and International Relations, Communications, and the Secretariat; the Directors of these units also report to the President. Finally, there is the Common Administrative Services Directorate. This directorate is shared with the Social Sciences and Humanities Research Council (SSHRC), and handles Human Resources, Information Management and Systems, Finance, and Administration for both Councils. Its Director General reports to the Presidents of both SSHRC and NSERC.

Figure 7: Corporate Structure



3. Departmental Performance

3.1 Performance Expectations

NSERC measures its performance by evaluating the programs of research and training support, their impact, cost effectiveness and continuing relevance. When reviewing performance indicators for assessing 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 Part III of the Main Estimates (1997-1998) and are summarized in the Chart of Key Results Commitments (p. iii). Highlights of performance expectations to **serve Canadians** include:

- high quality research capability maintained across all areas of 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.

3.2 Resources

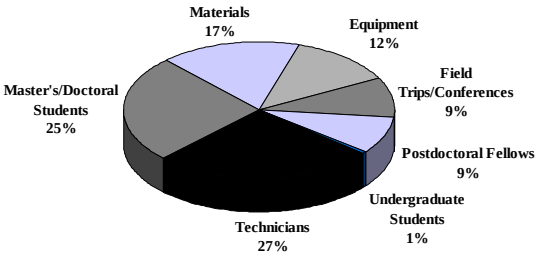
Figure 8 presents the resources devoted to NSERC's business line, Support of Research and Scholarship in the NSE. Spending in 1997-98 reached $435 million or 8 per cent of the federal government's expenditure on science and technology.

Figure 8: NSERC Expenditures, 1997-98

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

Planned Spending	$435,855,000
Total Authorities	$435,819,966
1997-98 Actuals	**$435,448,220**

Figure 9: NSERC Research and Training Expenditures, 1997-98



Total: $418 Million

Source: NSERC estimate based on 1996-97 expenditures.

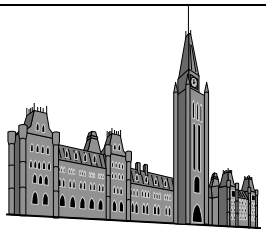
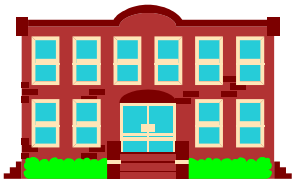
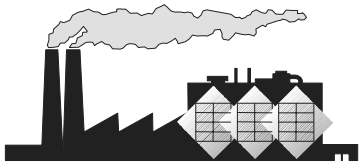
The 1997-98 spending for goods and services purchased by Canadian university researchers with NSERC grant funds, together with NSERC's direct scholarship spending, is presented in Figure 9. Over 60% of NSERC research and training funds in 1997-98 were used to pay technicians, undergraduate and postgraduate students, and postdoctoral fellows. This creates and sustains more than 12,000 high technology jobs every year. Materials, scientific equipment, and travel expenses for field trips and conferences make up the other 38% 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 $17 million (3.9% of total expenditures) brings the total for the year to $435 million. Additional financial information on NSERC program expenditures can be found in Section 5.5.

It should be noted that when a university researcher receives an NSERC grant, the funding can not 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.

3.3 Factors Influencing Performance

In assessing NSERC's performance, the environment in which it operates should be taken into consideration. Summaries of some important environmental factors that may influence NSERC performance are presented in Figure 10. Although these changes are for the most part outside NSERC's control, they have a strong impact on university research and training.

Figure 10: Factors Potentially Influencing NSERC Performance

Sector	Positive	Neutral to Negative
 **Federal Government**	• NSERC's budget increased to $494 million in 1998-99. • Canada Foundation for Innovation to offer first awards. • Tax breaks for university students in the 1998 budget. • NCEs made permanent.	
 **Provincial Governments**	• After several years of cutbacks to university operating grants, funding is beginning to stabilize in some provinces.	• Cutbacks at provincial research organizations continue.
 **Universities**	• Enrolment in the natural sciences and engineering at the bachelor's level is at an all-time high.	• Senior researchers are leaving the country for more lucrative jobs or accepting early retirement. • Lower funding levels are making it difficult for universities to cover the indirect costs of research. • Tuition fees are still on the rise, making foregone earnings an issue for more graduate students.
 **Industry**	• R&D spending and R&D employment have been increasing at a healthy pace. • The availability of venture capital funding for university spin-offs is increasing.	• Potential plateauing of industry support for university research and matching programs.
 **International**	• International scientific collaboration is increasing. • Large increase in number of immigrants coming to Canada with a science or engineering background.	• Emigration of skilled, young individuals in areas such as computer sciences in response to better personal income and/or research opportunities.

3.4 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) research and development, and (2) training.

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 3.4.3.

3.4.1 Research and Development

Across all its programs NSERC invested $272 million in R&D in 1997-98. This total excludes all expenditures on master's/doctoral students and postdoctoral fellows, which will be discussed in section 3.4.2. The results of this and prior investments are described below under ten indicators:

1. Publications
2. Patents
3. Awards and Prizes
4. International Expert Review
5. Licenses
6. Leveraging
7. Industrial Survey Results
8. Spin-Off Companies
9. New Products and Processes
10. Success Stories

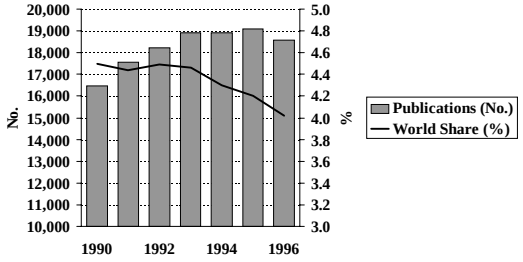
1. Publications

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, namely:

1. Publications (Cont'd)

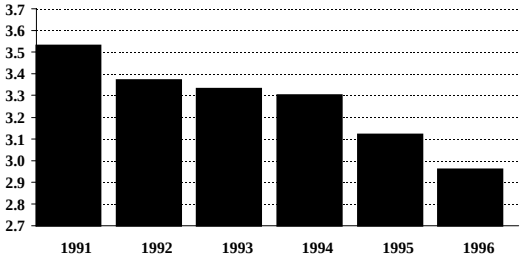
- Canadian researchers (all sectors) in the NSE publish roughly 19,000 journal articles per year, ranking Canada 6th overall in the world. This has represented a declining share of worldwide production, from 4.5% at the beginning of the decade to 4.0% in 1996 (see Figure 11). Most of Canada's and the world's scientific and engineering publications are produced by university researchers. The decline in Canada's share of university research spending in the OECD (Organization for Economic Co-Operation and Development, a good approximation for the world scene), as shown in Figure 12, follows roughly the same pattern as our world share of publications.

Figure 11: Number of Canadian Publications in the NSE and World Share



Source: Observatoire des Sciences et des Technologies

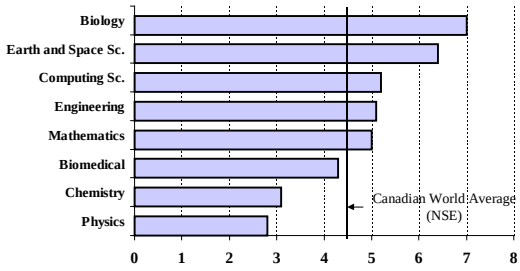
Figure 12: Canada's Share of University R&D Expenditures in the OECD (%)



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 13 indicates that for the most part this is being accomplished, with only two fields, chemistry and physics, significantly below the Canadian average for all fields.

Figure 13: Canada's Share of World Publications by Discipline in the NSE, 1991-96 (%)

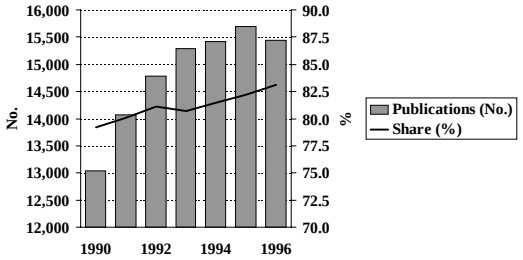


Source: Observatoire des Sciences et des Technologies

1. Publications (Cont'd)

- Most of Canada's NSE publications are produced by university researchers (see Figure 14). Of the 15,500 university papers produced annually, roughly 80% can be attributed to NSERC-funded researchers.

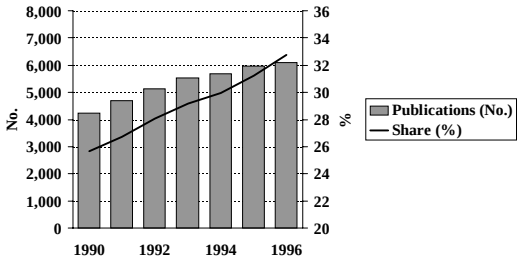
Figure 14: Number of Canadian Publications in the NSE by the University Sector, and Share of Canadian Papers



Source: Observatoire des Sciences et des Technologies

- Increasingly Canadian researchers in the NSE are collaborating with international partners and benefiting from the globalization of R&D. Figure 15 shows the trend over the past seven years, culminating in one-third of Canadian papers in the NSE being written with international partners.

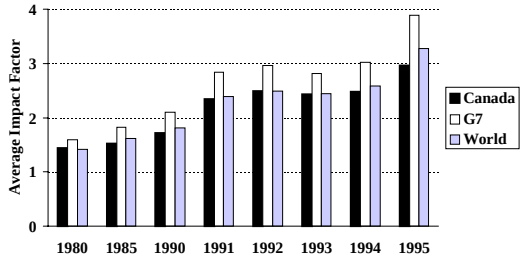
Figure 15: Number of Canadian Publications in the NSE Co-Authored with International Partners, and Share of Canadian Papers



Source: Observatoire des Sciences et des Technologies

- Figure 16 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 nearly equal to the world average and slightly below the G7.

Figure 16: Average Impact Factor of Publications in the NSE

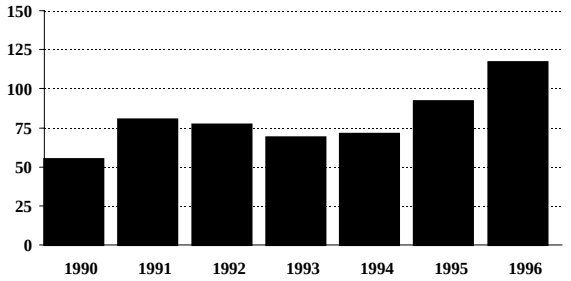


Source: Observatoire des Sciences et des Technologies

2. 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 17), 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 17: Number of U.S. Patents Issued to Canadian Universities in the NSE

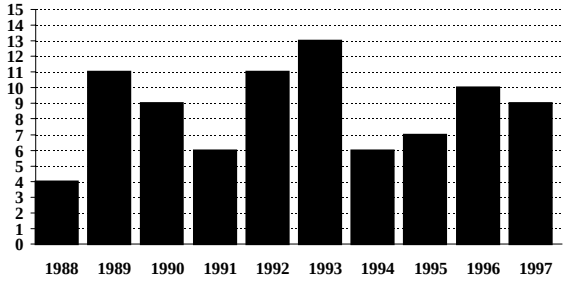


Source: Observatoire des Sciences et des Technologies

3. 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 18.)

Figure 18: Number of International Awards and Prizes Won by NSERC Funded Researchers



Source: NSERC

4. International Expert Review

Every four years NSERC conducts an extensive review of funding allocated to the various disciplines (e.g. chemistry, mathematics, mechanical engineering, etc.) in the NSE. The most recent review was conducted in 1998. The opinions of international experts are sought for the review. Although it is impossible to quantify the various comments, there did appear to be a theme in this year's feedback from over 100 international reviewers. These experts noted the high quality of Canadian research and were impressed by the ability of Canadian scientists and engineers to conduct world-class research, often with a lower level of support than researchers in other countries. Some of the comments made by these international experts are highlighted in the side box.

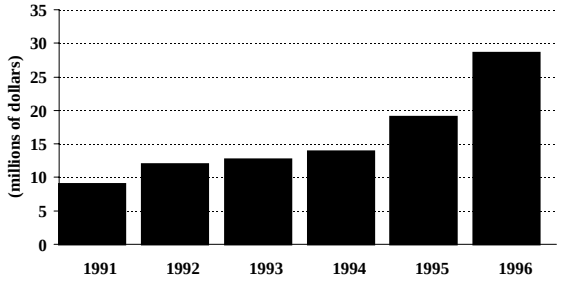
International Expert Comments on Canadian University Science and Engineering Research

- "The quality of Canadian research contributions in process technology are absolutely outstanding on an international scale."
- "…in computing and information sciences – Canada has a long tradition of excellence by the highest international standards: excellence in education, excellence in research, and excellence in impact."
- "Canadian researchers are currently among the top scientists in the world in statistics and probability."
- "Let me say by way of summary that Canadian psychology does very well internationally. Canadian psychologists are prominent in virtually every field of Psychology."

5. Licenses

One way university research is transferred to industry is through a license, 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 19 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 Medical Research Council (MRC). The trend in revenue growth is 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 three.

Figure 19: Canadian University Licensing Revenue (millions of dollars)



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

5. Licenses (Cont'd)

Examples of licenses based on NSERC-funded research include:

- At the University of Toronto, Dr. Richard Pilliar invented a biomaterial for dental implants. The technology was licensed to Toronto's Innova Corp., and to date has paid the university $1.1 million.

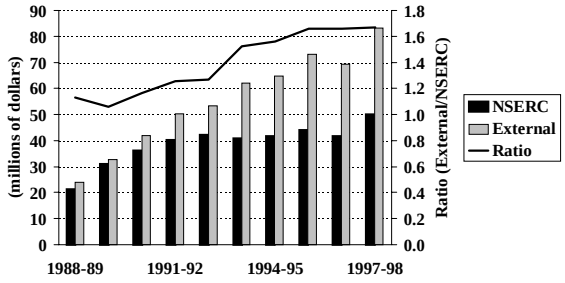
- Dr. Richard Peter, a zoologist at the University of Alberta, developed a treatment to induce spawning in aquaculture fish. Licensed to Vancouver's Syndel Laboratories, the drug is marketed under the name Ovaprim and has earned the university $70,000.

- An innovative speech compression algorithm was developed at the Université de Sherbrooke's *Groupe de recherche en information, signal et ordinateur*, led by Dr. Jean-Pierre Adoul. Their ACELP software has generated nine licenses and 14 sub-licenses internationally. In 1997-98, it contributed approximately $1.4 million to the university.

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 20.) From just over $23 million in 1988-89, contributions in 1997-98 reached $83 million, for a growth rate of 260 per cent over the ten-year period. The total contribution from NSERC partners over the decade is an impressive $555 million. A comparison of NSERC funding to partner contributions is also presented in Figure 20. The ratio of partner contributions to NSERC funding has been steadily increasing over the 10 years. From a low of 1.13 in 1988-89, this ratio now stands at 1.7. Put another way, for every dollar NSERC puts on the table for a University-Industry research grant, our partners contribute $1.70, demonstrating the value they place on the R & D.

Figure 20: Contributions to NSERC's University-Industry R&D Programs



Source: NSERC

7. Industrial Survey Results

NSERC undertook a pilot study to measure the outcomes of the Collaborative Research and Development (CRD) program, a program that brings university researchers and industrial partners together. NSERC plans to continue this work, and a summary of the industrial participants' perceptions of their CRD experience and some short-term outcomes from the pilot study are described below:

- In 34 of the 44 projects, the industrial partners expected commercializable results. Such results were achieved in 31 projects. Of those, 26 reached the implementation stage, with positive effects on the companies' competitiveness. In 20 cases the industrial participants reported no difficulties in the implementation of the research results.

- 41% of the industrial collaborators interviewed stated that "new products, processes, standards or services" were created as a result of the projects. 57% mentioned "improvement of existing processes or products", 86% "updating knowledge" and 68% having "access to new ideas" through the CRD projects.

- In 26 cases (59%), CRD projects resulted in positive competitive effects on the industrial partners. The impact on the company's competitiveness was mostly in terms of "gains of productivity" (17 cases), "profit" (15 cases), "sales" (8 cases) and "market share" (7 cases).

- The return on investment (ROI) of the CRD projects, as reported by the industrial partners, was "excellent" in 14 cases, "good" in 10 cases, "fair" in 11 cases and "poor" in 5 cases. There was "no reply" in 4 cases.

- 37 out of 44 industry participants (84%) still maintain a research relationship with their university partners: "formal or informal networks" (19 cases), "consulting contracts" (10 cases) and "collaborative research" (12 cases).

8. Companies Linked to NSERC-Funded Research

One of the more tangible outcomes of NSERC-funded research is the creation of a company. The "spin-off" companies highlighted in this report have all been founded on results of research partially funded by NSERC. The 108 spin-off companies featured (see Figure 21 on the next page) are currently in business producing goods and services for Canadian and international markets. Combined, these companies employ 5,806 Canadians and generate more than $1.1 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

Figure 21: Companies Linked to NSERC-Funded Research, 1969 to 1997
(number of employees in Canada in 1997)

Alberta
BIOMIRA (235)
Raylo Chemicals (135)
Wi-LAN (53)
D.B. Robinson and Associates (43)
Hycal Energy Research Laboratories (40)
Harding Instrument Company (35)
Itres Research (25)
SemBioSys (22)
Cel-LOC (17)
Boreal Laser (5)

Saskatchewan
SED Systems (250)
Wavecom Electronics (80)
Conservation Energy Systems (60)
DEL-AIR Systems (50)
Sci-Tec (33)
Biostar (28)
Droycon Bioconcepts (6)

Quebec
BioChem Pharma (357)
Les entreprises GIRO (120)
Ad Opt Technologies (50)
Pyrovac (27)
Advitech Solutions (25)
Infolytica (24)
Nexia Biotechnologies (AgroCultures Biotechnologies) (23)
INRO Consultants (23)
Hexavision (21)
Comlab Télécommunications (18)
Kemestrie (12)
Cosem Neurostim (7)
DephyTech (7)
Tekna Plasma Systèmes (7)
Bios Inc. (5)

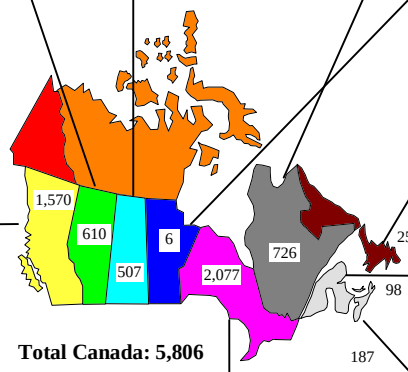
British Columbia
MacDonald Dettwiler and Associates (652)
Moli Energy (350)
QLT PhotoTherapeutics (115)
Brooks Automation (Techware) (100)
CTF Systems (80)
Forbes Medi-Tech (34)
Westport Innovations (28)
TIR Systems (25)
Vortek Industries (25)
Phero Tech (22)
Microtek International (18)
Terragen (15)
Aurora Instruments (12)
Barrodale Computing Services (11)
Credo (Kinetic Effects Research) (10)
Kinetic Sciences (10)
IGT Pharma (8)
Intertech Systems (8)
Assistive Listening Device Systems (7)
Mycologic (7)
Quantum Technology (6)
Wavemakers Research (6)
Arbutus Cove Systems (5)
Dewey McMillin & Associates (5)
Process Stimulations (5)
Albacore Research (4)
MicroXpress (2)

Manitoba
Sysmon (6)
Quantic Laboratories (Confidential)

Newfoundland
Guigné International (15)
AF Protein (10)

New Brunswick
Unisys (70)
EMR Technologies (28)

Nova Scotia
Focal Technologies (54)
Applied Microelectronics (50)
Pictorius (30)
Satlantic (20)
LAER Products (Ocean Nutrition Canada) (18)
MathResources (8)
Thermo Dynamics (7)



Total Canada: 5,806

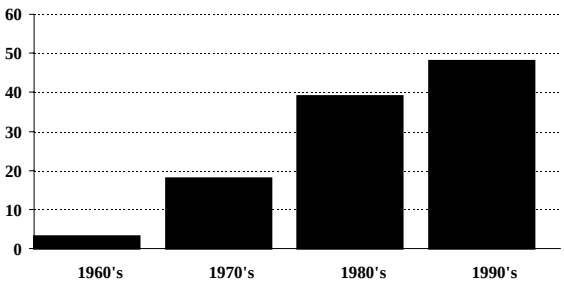
Ontario
MDS SCIEX (258)
Zenon Environmental (250)
Watcom (Sybase Waterloo) (240)
Dalsa (185)
Inverpower Controls (155)
Open Text (130)
Sacda (130)
Certicom (MOBÏUS Encryption Technologies) (75)
Optech (75)
Pavement Management Systems (75)
Waterloo Maple Software (70)
Platform Computing (60)
Powerlasers (40)
Virtek Vision (40)
Diffracto (33)
Innova Technologies (30)
Imaging Research (26)
Dynacon Enterprises (25)
Legasys (21)
Turbotak Technologies (21)
Ensyn Technologies (17)
Waterloo Scientific (16)
Hydromantis (14)
Polyphalt (11)
Hydrasil (10)
Millennium Biologix (10)
Performance Plants Biotechnology (10)
Estco Energy (9)
Apollo Environmental Systems (7)
Biorem Technologies (7)
Electrophotonics (6)
Qubit (6)
Ask Science Products (4)
Elstat (4)
EnviroMetal Technologies (4)
New Orbit Technologies (3)

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

these advanced technology companies, which are 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 17 in Section 5.5.

The pace of "spin-off" company formation seems to be accelerating (see Figure 22). As more researchers embrace the entrepreneurial spirit to launch a company, we can expect more and better things to come in the future.

Figure 22: Number of NSERC-Related Spin-off Companies by Decade of Incorporation

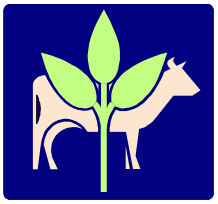
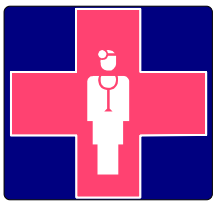
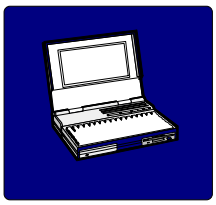


Source: NSERC

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 23.

Figure 23: Examples of New Products and Processes Developed by NSERC-Funded Researchers by Sector

 **Agriculture**	➢ Canola ➢ Cold- and salt-tolerant wheat, rice and forage crops ➢ Vaccines to prevent diseases in cattle, pigs, and aquaculture fish ➢ FRUIT BOOST, a bee pollination enhancement product for orchards and berry crops ➢ Environmentally friendly soybean treatment to replace or supplement fertilizer ➢ Anti-freeze proteins to stimulate growth in aquaculture fish
 **Construction**	➢ Light Pipes, a lighting system for inaccessible areas ➢ Heat exchangers for homes, offices, and livestock barns ➢ Corrosion-resistant (composite) materials for bridges and buildings ➢ High-performance concrete ➢ Pavement engineering technologies for roads ➢ Waste plastics-based binder for asphalt and roofing products
 **Transportation and Aerospace**	➢ D Sight: software for quality control of metal, glass and plastic ➢ Laser blanking system for the manufacture of auto parts ➢ Hydrogenated nitrile butadiene: a heat-resistant polymer for auto parts like hoses, gaskets, and belts ➢ Simulation tools to prevent icing on aircraft wings and engines ➢ Machine vision systems for parts manufacture in automotive and aerospace industries ➢ Altitude software for flight and crew scheduling ➢ Scheduling system for public transportation ➢ Software for planning urban transportation systems
 **Health**	➢ Photodynamic therapies for treatment of cancer and other diseases ➢ 3TC, part of the drug "cocktail" for treatment of HIV and AIDS ➢ Cochlear implant with a multi-language speech processor ➢ Prosthetic feet and myoelectric arms ➢ Dental implants ➢ Brain scanning devices ➢ Synthetic bone for replacement
 **Computers and Communications**	➢ Encryption software for electronic commerce and communication ➢ Ultra-fast wireless modems ➢ Smart antenna for PCs ➢ Life Forms animation software ➢ Intranet applications ➢ Load Sharing Facility to create virtual supercomputer ➢ Prograph, an object-oriented programming technology

10. Success Stories

Here are some 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. This year's theme is: "How NSERC-funded research contributes to important economic sectors in each province."

Newfoundland: engineering success for offshore oil

Offshore oil projects Hibernia and Terra Nova hold great potential for the Canadian economy. However sea ice and icebergs make it difficult to operate in the North Atlantic. Memorial University's Ian Jordaan is making it safer to work in this hostile environment. His research has produced some important design criteria for structures and vessels operating in ice-ridden waters. He helped to set new standards for fixed offshore structures and his findings have been implemented in the Hibernia project. His work on strengthening Hibernia's shuttle tanker against ice has also led to new Canadian rules for Arctic Pollution Prevention.

Saving salmon a priority for PEI researcher

Atlantic Canada's salmon aquaculture industry is worth an estimated $130 million per year. In 1995, the industry suffered losses of almost $20 million from sea lice. The parasites live on the skin of the salmon, causing tissue damage, growth reduction, and even starvation. Unfortunately the chemicals used to kill the pests are hard on the fish, as well as expensive, labour intensive, and unfriendly to the environment. At the University of Prince Edward Island, John Burka is looking for better ways to control sea lice. He is developing alternative strategies that are effective, affordable, and environmentally sound. Ultimately, he hopes to develop a drug or vaccine to protect salmon against this devastating parasite.

10. Success Stories (Cont'd)

Nova Scotia technology makes coal come clean

Coal is one of the world's most popular sources of energy. It's also inefficient and highly polluting. Utilities using high-sulphur coal have had to install scrubbers to control air pollution, but they can be unreliable and nearly as expensive as the plant. At DalTech, mechanical engineer Prabir Basu is refining a better method: the Circulating Fluidized Bed process. CFB burns crushed, rather than pulverised coal, and at lower temperatures. It is twice as efficient as conventional technology, cuts emissions in half, and is affordable, since it is retrofitted to old boilers. Countries around the world will be able to enjoy cleaner power while still using local, low-grade coal. The system is being marketed internationally.

Travel virtually anywhere using New Brunswick software

Research conducted at the University of New Brunswick will let you travel the ocean floor without leaving your desk. Researchers at the Ocean Mapping Group pioneered desktop exploration with interactive visualization software and tools. Led by Colin Ware and Larry Mayer, they developed software to transform complex data into 3-D maps and even videos. Initially, these products were targeted at scientific applications, such as exploring submarine cable routes and modelling complex climate data. But clients have found that the tools have many other uses, from architecture, design, and landscape development, to the medical and entertainment industries. Customers in Europe and North America use this system.

Quebec: Copying the chemical complexity of nature

At the Université de Sherbrooke, chemist Pierre Deslongchamps has devised a new approach for fabricating natural products. This enabled him to synthesize a number of highly complex molecules, including one of the most important antibiotics, erythromycin A. World-wide, industrial and university labs have enthusiastically adopted Dr. Deslongchamps' techniques. Laval's Biomega Boehringer Ingleheim has implemented his method for producing '14 beta' hydroxy steroids from two simple compounds. Research with other synthetic corticosteroids -- compounds used to control asthma, allergies, inflammation and arthritis -- is close to industrial implementation.

Nortel teams with Ontario researcher to build telecom's next generation

Nortel is a world-leader in the manufacture of communications technology. But to stay at the top, you must keep innovating. Collaboration between Nortel and University of Toronto's Dr. JingMing Xu produced new physics, novel devices, and enabling technologies at the forefront of light wave communications systems. In 1987, the company teamed up with NSERC to establish a research chair on the physics of compound semiconductor devices. These are critical components in fiber optic communications systems. The partnership has led to new equipment, as well as six world-class performance records. These technologies are the building blocks for the next wave of communication products.

10. Success Stories (Cont'd)

Manitoba researchers banish bugs from grain stores

Grain and oilseeds are a multi-billion dollar Canadian industry. But getting the best price depends on maintaining quality throughout storage and handling. Insects pose a major problem. Many chemicals used to treat insects have been banned because of their toxicity, leaving producers few options to control pests. The University of Manitoba's Grain Storage Systems group, directed by Digvir Jayas, is the only team in the world to holistically examine the use of CO_2 to kill pests. Dr. Jayas has elaborated the most effective procedures for the use of dry ice to kill insects in grain stores. The strategy costs roughly the same as chemical pesticides, but is safe to administer, residue-free, and friendly to the environment. The technique has already been adopted by some grain handling facilities.

Saskatchewan research fuels new developments in ethanol

Good things are brewing at the University of Saskatchewan. Mike Ingledew's group of fermentation scientists successfully overturned established beliefs about the ethanol tolerance of yeasts, to the benefit of the brewing and fuel alcohol industries. By adding nitrogen "foods" and oxygen to nutrient-limited grain extracts, the team found that yeasts synthesized stronger cell membranes. This means beer can be made with as much as 16.4% alcohol and fuel alcohol with up to 23% alcohol by volume. Fermenting at such high levels lowers production costs, making brewing and fuel alcohol industries more competitive. Industry is now adopting the principles of this technology for the manufacture of beer, and is looking at its use for fuel manufacture.

Alberta research making waves in oil and gas industry

Getting a clearer picture of what lies beneath the earth's surface is critical to resource companies. The Consortium for Research in Elastic Wave Seismology (CREWES) is breaking new ground in subsurface imaging. Drs. Donald Lawton and Robert Stewart lead the Consortium of researchers and 35 petroleum and resource companies. The group has developed some of the most advanced tools for "seeing" under the earth's surface and has trained industry employees in their use. Their approach provides images not just of geological structures but of the actual rock types making up the structures. As a result, industry will be able to drill for oil and gas with greater certainty.

The sweet smell of research success in British Columbia

Pulp mills are vital to Canada's forestry industry. But people in communities near these mills will tell you that they stink - literally. In a few cases, the smell was so bad that the mill had to be closed. Research at the University of British Columbia may prevent such drastic action. Kenneth Pinder, a chemical engineer with expertise in the pulping process, has taken aim at odours emitted from pulp mills. While companies have removed the most objectionable chemical pollution, it is too costly to eliminate odours from the remaining small emissions. Dr. Pinder is adapting biofilters used in composting operations, sewage plants, and foundries. Since these biofilters are inexpensive and easy to use, they should bring a breath of fresh air to the neighbourhood.

3.4.2 Training

NSERC invested $146 million in 1997-98 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 we will experience a decline in Canada's 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 5.7.

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

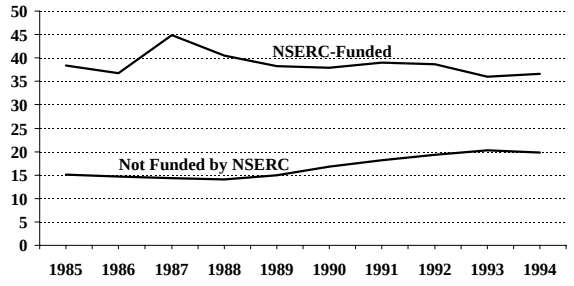
1. Undergraduate Students Going on to Graduate School
2. Career Progression of Master's and Doctoral Students
3. Career Progression of Postdoctoral Fellows
4. Career Progression of Industrial Research Fellows

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 has made an annual investment of $9 million to bring this experience to more than 2,000 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..

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

Figure 24: Percentage of Undergraduate Students Who Go On to Graduate School (%)



Source: NSERC estimates.

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 24 indicates that NSERC-funded undergraduates are on average twice as likely to go on to graduate school as those not funded by NSERC.

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. We do this in two ways: (1) directly through national programs supporting more than 3,000 students annually at a cost of $40 million per year; and (2) indirectly through NSERC's research grants, which support more than 4,000 students (full-time equivalent), at roughly $60 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 four years NSERC has completed four surveys of directly-funded master's and doctoral students. A total of 990 former NSERC-funded students have replied (a response rate of nearly 55%). Just under half (47%) 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

- "The NSERC scholarship was the most valuable source of support for both my training and my current job."
- "...I chose to return to Canada because of the investment Canada made in me. Without financial support it would not have been possible to pursue post-graduate studies."
- "The money spent by NSERC to encourage me in my studies has already been recouped many times over through income tax. It's a sound investment."
- "I am very grateful for the support that NSERC provided. It absolutely influenced my decision to enrol in graduate studies, which directly lead to my position in academia. Thanks NSERC!"

The major findings of the first four surveys can be summarized as follows:

- The unemployment rate for respondents is estimated to be less than 2%.
- 82% of the respondents (employed or self-employed individuals in a full-time position in Canada) have an annual salary greater than $45,000.
- 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.

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

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

- 173 respondents (17% 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 the 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 invests approximately $9 million per year to support roughly 400 Canadian PDF's per year. NSERC also provides this PDF support for more than 800 other individuals through NSERC research grants. We plan to conduct a survey of our previously funded postdoctoral fellows in the coming year. The survey will be similar to the master's and doctoral students' survey presented above. It is anticipated that the career results will be as positive as for the master's and doctoral population, since 60% of our postdoctoral fellows held an NSERC postgraduate scholarship.

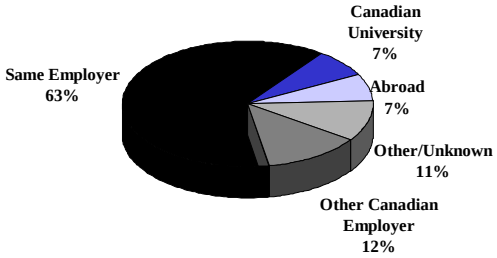
4. Career Progression of Industrial Research Fellows

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 150 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 our IRF program.

4. Career Progression of Industrial Research Fellows (Cont'd)

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 25 shows the current employer for the 761 Fellows who finished their award from 1980 to 1997. Seventy-five 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 25: NSERC's Industrial Research Fellows: Where Are They Now?



Total: 761

Source: NSERC Industrial Research Fellows from 1980 to 1997.

NSERC also surveys representatives of the company where the Fellows worked, or their supervisors. Surveys from over 100 companies involving 276 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 95% 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

- "I think the program is excellent, benefiting both the fellow and the company involved."
- "Our small company could not have been able to undertake much of the R&D without this program."
- "This is a great program. It helps top quality graduates get exciting roles in industry. The paperwork is "bearable" and bureaucracy is helpful."
- "The IRF is an excellent way for meeting the needs of research students and the R&D needs of industry at the same time.
- "Generally excellent program. Well administered. Very efficient. The program is excellent and very beneficial to smaller high tech companies such as ours."

3.4.3 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 1997-98 include:

- January 1998 saw the successful release of the *NSERC Award Management Information System* (NAMIS). NAMIS is a bilingual, Year 2000-compatible, client-server application consistent with the latest software standards and the Treasury Board *Blueprint*. Among other features, NAMIS offers users a Council-wide integrated database, flexible awards administration, powerful query and reporting tools, and detailed online help. NAMIS provides the foundation for many other service initiatives and will no doubt lead to new innovations.
- *Electronic Forms Project* is a combined effort of four councils — NSERC, SSHRC, MRC and the *Fonds pour la formation de chercheurs et l'aide à la recherche* (FCAR) in Quebec. This project was launched four years ago to consolidate the application process of the federal and provincial granting councils. By the end of 1998-99, applicants should be able to complete an electronic application form using the World Wide Web and print it locally.
- 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. Revised policies and procedures will take effect in 1999-2000.
- Changes have been made to NSERC's monitoring policies and procedures to enhance efficiency and ensure a continued high degree of accountability for public funds. Several other recommendations will be phased in over the course of the next fiscal year.
- The new *Manual of Good Practices* that consists of a compilation of universities' best practices for administering grants will be updated yearly to help universities improve aspects of their control framework.
- A single point of contact for each university has enabled the consistent application and interpretation of the Council's priorities, as well as improved working relationships with clients.
- NSERC will streamline the application and review procedures for the project grant programs.
- 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. A web-based searchable database is being developed this year to permit anyone to run queries on NSERC-funded research.

3.4.4 Y2K Initiatives

NSERC has made good progress in assuring that the Council's internal systems function correctly during and after the Year 2000. The Council has established, in partnership with the Social Sciences and Humanities Research Council and the Medical Research Council, a working group to develop the Councils' joint response to external Y2K issues – those associated with the institutions and activities supported by NSERC, SSHRC and MRC awards.

With the successful implementation of NAMIS (NSERC Award Management Information System) in January 1998, NSERC has made its major mission-critical internal business software fully Y2K-compliant. NAMIS is a bilingual, GUI-based, Windows-compatible, client-server system that was developed consistent with Treasury Board standards and the *Blueprint* document. NSERC's Treasury-Board-approved Human Resources system, HRIS, is Y2K-compliant.

However, the Finance system (FreeBalance, DOS version) is non-compliant and a high priority for replacement. A contract with the selected software supplier will be signed shortly and a new compliant system will be implemented by April 1, 1999.

With respect to the external clientele, the NSERC/SSHRC/MRC Y2K Working Group has prepared a draft communication to Canadian universities to raise Y2K awareness and stimulate action where it may not exist at the moment.

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 Tables were not applicable to NSERC. There were no major differences between planned and actual spending levels for 1997-98.

4.2 Financial Summary Tables

Table 1: Summary of Voted Appropriations

A. Authorities for 1997-98 – Part II of the Estimates
Financial Requirements by Authority
(millions of dollars)

Vote		1997-98 Planned Spending	1997-98 Total Authorities	1997-98 Actual
	Natural Sciences and Engineering Research Council Program			
85	Operating expenditures	15.2	16.3	**16.0**
90	Grants	417.2	418.0	**418.0**
(S)	Contributions to employee benefit plans	1.5	1.5	**1.5**
	Total Program	*433.9*	*435.8*	***435.4***
	Total Agency	**433.9**	**435.8**	**435.4**

Note: Due to rounding, figures may not add to totals shown.

Table 2: Comparison of Total Planned to Actual Spending

Departmental Planned versus Actual Spending by Business Line
(millions of dollars)

Business Line	FTEs	Operating[1]	Capital	Voted Grants & Contributions	Subtotal: Gross Voted Expenditures	Statutory Grants & Contributions	Total Gross Expenditures	Less: Revenue Credited to the Vote	Total Net Expenditures
Support of	191	16.7	—	417.2	433.9	—	433.9	—	433.9
Research and	*191*	*17.8*	—	*418.0*	*435.8*	—	*435.8*	—	*435.8*
Scholarship	**193**	**17.5**	—	**418.0**	**435.4**	—	**435.4**	—	**435.4**
Total	191	16.7	**—**	417.2	433.9	**—**	433.9	**—**	433.9
	191	*17.8*	—	*418.0*	*435.8*	—	*435.8*	—	*435.8*
	193	**17.5**	—	**418.0**	**435.4**	—	**435.4**	—	**435.4**

[1] Operating includes contributions to employee benefit plans and minister's allowances

Other Revenues and Expenditures

Revenue credited to the Consolidated Revenue Fund	(0.06)
	(0.06)
	(0.39)
Cost of services provided by other departments	1.73
	1.73
	1.69
Net Cost of the Program	435.5
	437.5
	436.7

Note: Numbers in normal font denote planned spending for 1997-98.
Numbers in italics denote Total Authorities for 1997-98.
Bold numbers denote actual expenditures/revenues in 1997-98.
Due to rounding, figures may not add to totals shown.

Table 3: Historical Comparison of Total Planned to Actual Spending

Departmental Planned versus Actual Spending by Business Line
(millions of dollars)

Business Line	Actual 1995-96	Actual 1996-97	Planned Spending 1997-98	Total Authorities 1997-98	Actual 1997-98
Support of Research and Scholarship	468.9	451.6	433.9	435.8	**435.4**
Total	**468.9**	**451.6**	**433.9**	**435.8**	**435.4**

Table 4: Crosswalk between Old Resource Allocation and New Allocation

Not applicable to NSERC.

Table 5: Resource Requirements by Organization and Business Line

Not applicable to NSERC.

Table 6: Revenues to the Vote

Not applicable to NSERC.

Table 7: Revenues to the CRF

Revenues Credited to the Consolidated Revenue Fund by Business Line
(thousands of dollars)

Business Line	Actual 1995-96	Actual 1996-97	Planned Revenues 1997-98	Total Authorities 1997-98	Actual 1997-98
Support of Research and Scholarship	395	105	60	60	**386**
Total Revenue Credited to CRF	**395**	**105**	**60**	**60**	**386**

Table 8: Statutory Payments

Not applicable to NSERC.

Table 9: Transfer Payments

Transfer Payments by Business Line
(millions of dollars)

Business Line	Actual 1995-96	Actual 1996-97	Planned Spending 1997-98	Total Authorities 1997-98	Actual 1997-98
GRANTS					
Support of Research and Scholarship	451.9	434.7	417.2	418.0	**418.0**
Total Grants	**451.9**	**434.7**	**417.2**	**418.0**	**418.0**
CONTRIBUTIONS					
Support of Research and Scholarship	—	—	—	—	—
Total Contributions	**—**	**—**	**—**	**—**	**—**
Total Transfer Payments	**451.9**	**434.7**	**417.2**	**418.0**	**418.0**

Table 10: Capital Spending by Business Line

Not applicable to NSERC.

Table 11: Capital Projects by Business Line

Not applicable to NSERC.

Table 12: Status of Major Crown Projects

Not applicable to NSERC.

Table 13: Loans, Investments and Advances

Not applicable to NSERC.

Table 14:.Revolving Fund Financial Summaries

Not applicable to NSERC.

Table 15: Contingent Liabilities

Not applicable to NSERC.

5. Other Information

5.1 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:

Mr. Steve Shugar
Director, Policy and International Relations
Tel. (613) 995-6449
Fax (613) 947-5645
E-Mail sbs@nserc.ca

Or

Mr. Barney Laciak
Senior Planning Analyst, Policy and International Relations
Tel. (613) 996-1079
Fax (613) 947-5645
E-Mail bjl@nserc.ca

5.2 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.

5.3 Other Departmental Reports

Copies of the following reports are available:

- Annual Report 1996-97
- Annual Report 1996-97, Networks of Centres of Excellence
- NSERC Facts and Figures 1996-97
- Postgraduate Surveys
- 1997-98 Estimates
- Longer-Term Performance Indicators for the Collaborative Research Development Program
- Performance Indicators for the Research Grants Program

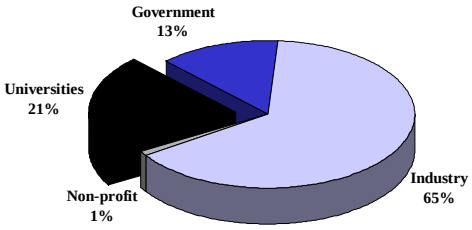
5.4 University Research in Canada

(Refer to Section 2.2)

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

1. University researchers conducted 21% of all Canadian research, as measured by expenditures, in 1997 (see Figure 26).
2. Of the $2.8 billion of direct and indirect investment in Canadian university research in 1997, 41% was allocated to the natural sciences and engineering (see Figure 27).
3. Figure 28 shows trends in the funding of Canadian university research in the NSE. Over the past ten years the Federal government's share has declined, while industry and universities have contributed a greater portion.
4. Canadian university researchers perform 3% of the nearly $100 billion in university research in the OECD (see Figure 29). When measured as a percentage of GDP, Canada conducts roughly the same amount of university research as most of its G7 competitors.

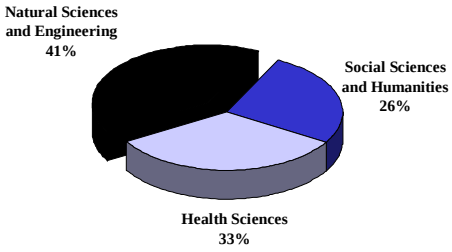
Figure 26: R&D Performance in Canada, 1997



Total: $13.4 Billion

Source: Statistics Canada

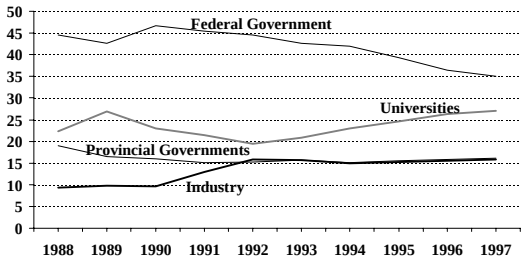
Figure 27: University R&D in Canada by Discipline, 1997



Total: $2.8 Billion

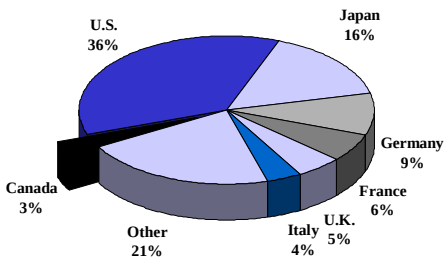
Source: Statistics Canada

Figure 28: Canadian University R&D Funding in the Natural Sciences and Engineering (%)



Source: Statistics Canada

Figure 29: University R&D Expenditures in the OECD, 1996



Total: $95.9 Billion

Source: OECD

5.5 Supplementary Tables

Table 16: NSERC Expenditures by Program (thousands of dollars)

	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98
Research Grants Programs	219,554	229,419	252,908	264,626	271,317	267,906	277,237	263,130	265,605	243,905
Research Partnerships	61,340	73,116	120,674	120,011	124,842	120,951	116,190	119,108	112,669	116,955
Training (Direct Support)	57,016	61,677	64,851	70,914	76,417	78,149	72,961	67,570	54,348	54,139
General Support	12,337	11,138	10,399	10,269	10,112	9,719	8,607	2,048	2,115	2,984
GRANTS AND SCHOLARSHIPS	350,247	375,350	448,832	465,820	482,688	476,725	474,995	451,856	434,737	417,984
Administration	14,318	16,645	17,410	16,292	16,560	18,138	17,613	17,019	16,905	17,464
TOTAL EXPENDITURES	364,565	391,995	466,242	482,112	499,248	494,863	492,608	468,875	451,642	435,448

Table 17: Spin-off Companies Linked to NSERC-Funded Research by Province

Province	Number of Companies	Number of Employees	Annual Sales/ Revenue (millions of $)
British Columbia	27	1,570	263.7
Alberta	10	610	63.7
Saskatchewan	7	507	75.6
Manitoba	2	6	0.2
Ontario	36	2,077	478.1
Quebec	15	726	277.7
New Brunswick	2	98	10.7
Nova Scotia	7	187	15.7
Newfoundland	2	25	3.1
TOTAL	108	5,806	1,187.4

Source: NSERC

5.6 Peer Review Explained

(Refer to Section 2.3)

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.

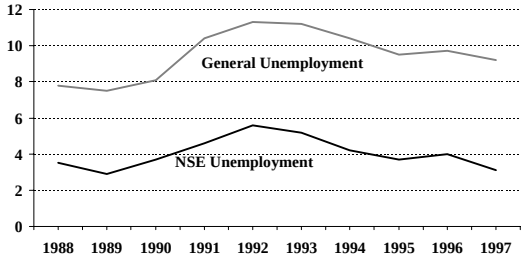
5.7 Analysis of Impact of Training Support

(Refer to Section 3.4.2)

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:

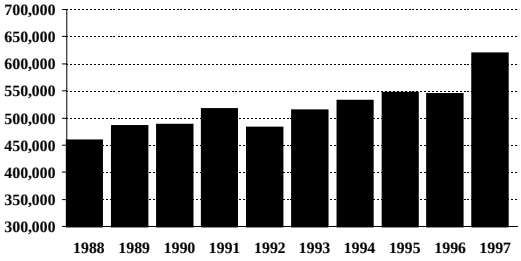
1. The demand for such people is high, as indicated by a very low unemployment rate for Canadians in the natural sciences and engineering, less than one-half the rate for the general population (see Figure 30).
2. Employment growth for natural scientists and engineers is strong (see Figure 31) and one 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 32).
4. Canada needs more research scientists and engineers to compete with the highly industrialized nations of the world (see Figure 33).

Figure 30: Unemployment Rate for Natural Scientists and Engineers (%)



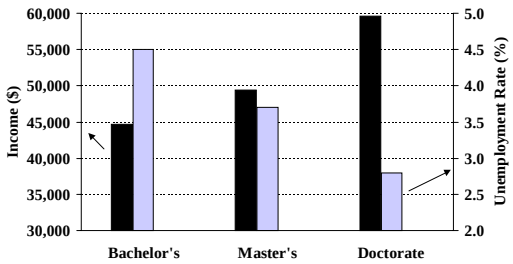
Source: Statistics Canada

Figure 31: Number of Natural Scientists and Engineers Working in Canada



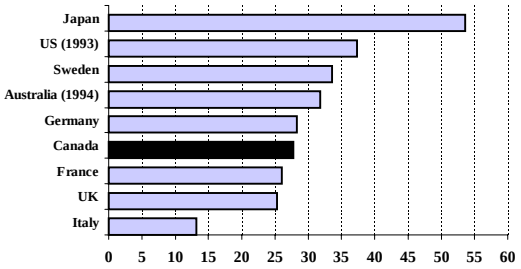
Source: Statistics Canada

Figure 32: Income and Unemployment Levels by Degree Level for Graduates in the NSE, 1995



Source: Statistics Canada

Figure 33: Scientists and Engineers Engaged in R&D per 10,000 Population, 1995



Source: OECD

6. Reader's Survey

We would like to hear from Canadians who have read this report. Your comments will help ensure that we provide information that is easy to understand and relevant. We 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
NSERC
Policy and International Relations
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.