Natural Sciences and Engineering Research Council of Canada

1997-98
Estimates

Part III

Expenditure Plan

The Estimates Documents

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Natural Sciences and Engineering Research Council of Canada

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Part III

Expenditure Plan

Approved

President	Minister of Industry

The Minister's Message

The Industry Portfolio
Building Jobs and Growth through Partnerships and Innovation

The Natural Sciences and Engineering Research Council (NSERC) is a member of the Industry Portfolio. NSERC is the national instrument for making strategic investments in Canada's capability in science and technology. NSERC supports basic university research through research grants and project research through partnerships of universities with industry, as well as the advanced training of highly qualified people in both areas. Over 8,000 Canadian university researchers benefit from NSERC support. In addition, over 3,300 Canadians hold an NSERC scholarship or fellowship.

Through the coordinated efforts of its members organizations, the Industry Portfolio is playing a vital role in helping to improve economic growth, and employment and income prospects for Canadians. The Industry Portfolio brings together the key departments and agencies responsible for science and technology, regional development, marketplace services and micro-economic policy. In doing so, the Government of Canada has created a new capacity for partnership and innovation, both within the Portfolio itself and externally, with the private sector and other stakeholders.

As Minister responsible for the Industry Portfolio, I am focussing the Portfolio's activities to help Canadians move confidently into the 21st century. Through the Portfolio, I am working to ensure that our businesses and industries have the best tools and the right conditions to innovate, grow, compete and generate jobs.

The Industry Portfolio Is ...

- Atlantic Canada Opportunities Agency
- Business Development Bank of Canada
- Canadian Space Agency
- Competition Tribunal
- Copyright Board of Canada
- Federal Office of Regional Development (Quebec)
- Industry Canada
- National Research Council of Canada
- Natural Sciences and Engineering Research Council of Canada
- Social Sciences and Humanities Research Council of Canada
- Statistics Canada
- Standards Council of Canada
- Western Economic Diversification

The technology-driven global economy which has emerged in the 1990s holds much promise, as well as many challenges. To maintain traditional strengths and markets while building new ones, Canadians must innovate. We have to develop and use leading edge technologies and skills needed in the knowledge-based economy. We need to increase the abilities of our

firms and industries to export. We must also enlarge Canada's share of international investment. And we must work to ensure all Canadians, especially our youth, are able to participate fully in the new economy. To achieve these goals, business, governments and individual Canadians have to work together, in partnership.

The Industry Portfolio is playing its part by focussing on three areas of activity -- each crucial for our economic success, now and into the next century:

- promoting innovation through science and technology
- assisting business to grow by providing information, advice and financing support
- ensuring a fair, efficient and competitive marketplace.

Innovation is the key to success in the global economy. Creative thinking and adopting new technologies and processes keep traditional industries competitive while launching new industries for emerging and expanding markets. The Industry Portfolio is taking a new, risk-sharing approach to investing in technology through partnerships with the private sector. We are also making strategic investments to expand Canada's intellectual resources and advance knowledge.

The Portfolio assists Canadian businesses to increase their competitive advantage and their capacity to expand. Our actions are particularly directed at strengthening the backbone of Canada's economy -- small and medium-sized enterprises.

The Industry Portfolio has a vital role to ensure an open and efficient marketplace by setting clear and fair "rules of the game." In this way, we are supporting business activity while protecting consumer and investor interests.

Through its wide range of activities, the Industry Portfolio is contributing to economic growth, increased employment and higher living standards for Canadians in every region, both today and into the new century.

John Manley
Minister of Industry

Preface

This document is a report to Parliament to indicate how the resources voted by Parliament have or will be spent. As such, it is an accountability document that contains several levels of detail to respond to the various needs of its audience.

The Part III for 1997-98 is based on a revised format intended to make a clear separation between planning and performance information, and to focus on the higher level, longer term plans and performance of the Council.

The document is divided into four sections:

- An Executive Summary;
- NSERC's Planning;
- NSERC's Performance; and
- Supplementary Information.

It should be noted that, in accordance with Operating Budget principles, human resource information reported in this document is shown in terms of employee full-time equivalents (FTEs).

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Section I - Executive Summary

The Natural Sciences and Engineering Research Council makes strategic investments in university research and training, investments that are crucial to Canada's continued economic and social progress. Today the availability of public funds is reduced; the federal government and most provinces are still reducing expenditures to eliminate their deficits, and all governments are concerned with their debt levels. In this fiscal climate, we must be very conscious of the effectiveness of our programs and the return on our investments. NSERC makes high-leverage investments; each NSERC dollar attracts at least an equal amount from other sources. NSERC investments build Canada's stock of knowledge in the natural sciences and engineering, provide access to knowledge developed in other countries, and give young Canadians the advanced training they need in order to compete in a rapidly changing, high-tech world. New knowledge leads to innovation - both in products and processes - which creates new economic activity, protecting and creating high-quality jobs and the high quality of life that Canadians enjoy.

Part III of the Main Estimates for 1997-98 outlines NSERC's plans and priorities, and provides some information on the challenges facing the Council, the indicators by which performance is evaluated, and, perhaps most importantly, the context in which Canada's university researchers do their work.

The Council's planning arises from the mandate in our Act, that is, "... *to promote and assist research in the natural sciences and engineering*...." To carry out that mandate effectively, Council had to protect the support for basic university research. This was done to maintain the capacity for innovation in Canada, because NSERC has become the nation's only significant source of support for discovery in the natural sciences and engineering. Project research which puts new knowledge to productive use depends on having a fresh stock of knowledge. Project research is encouraged by NSERC and flexible mechanisms have been developed to leverage the support for it through university-industry partnerships. Training is vital in all NSERC-sponsored research: researchers must address the issue of training when applying for funding. In addition, NSERC has begun to address the needs of the next generation of Canadian researchers, those who are now in graduate school and at the start of their research careers. These people are the future of Canadian research, and will face a very different working environment from that of their predecessors. Their success will be crucial to Canadian prosperity in the next century.

NSERC's performance is judged in terms of our planning and our mandate: programs are evaluated in terms of their impact on Canada and Canadian society, as well as in terms of their outputs and inputs. At a time when most sources of funding for university research and scholarship are under strain, it is essential to ensure that Canadians receive the best possible return on their research investment; systematic and appropriate evaluation is key to obtaining this assurance.

Section II - Planning

A. Summary

NSERC's planning must take into account the following challenges in Canada's current university environment:

- Reductions in funding to the Council, as well as the other two university research funding councils (the Medical Research Council and the Social Sciences and Humanities Research Council); these three councils provide the bulk of support for basic university research in Canada;
- Reductions in provincial funding to universities; this provincial funding provides about half the cost of research in the form of indirect support for research, as well as for faculty salaries, university infrastructure, and so on;
- Increasing university enrolments, putting more pressure on university teachers and making less time available for research;
- Increasing university tuitions in many provinces, making graduate studies a less attractive option for students, and putting additional pressure on NSERC funds for student support;
- Increasing cost of research, including the demand for advanced, high-cost research instrumentation and facilities required for Canadian research to address the modern important areas; and
- Increased demand for accountability from funders, students, and universities.

NSERC is dealing with these challenges by:

- Focusing on core activities - that is, on the support of university-based research and training;
- Maintaining the funding level of the Research Grants program, so as to ensure support for basic university research in the natural sciences and engineering, for which NSERC is the only funding source;
- Providing mechanisms that build links among university researchers and other sectors - this is especially important in linking university researchers with industry. It is also vital in ensuring Canadian participation in large international research projects, and in building large multi-disciplinary research facilities in Canada;
- Ensuring that programs are flexible so they can be quickly adapted to meet the changing needs of university research;
- Working with students and new researchers to ensure that NSERC's programming will be effectively targeted at the needs of the next generation of researchers;
- Continuing to ensure that only the best research proposals and projects receive scarce funding, using the peer-review process; and

- Developing performance indicators to systematically evaluate the Council's programming.

B. Overview

1. What is NSERC?

NSERC - the **Natural Sciences and Engineering Research Council** - is Canada's leading agency making strategic investments in our capabilities in science and technology. In practical terms, NSERC is an arm's-length agency of the federal government, funded directly by Parliament and reporting to it through the Minister of Industry. NSERC was created in 1978 by an Act of Parliament, and given a mandate 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 such research as the Minister may refer to the Council for its consideration.*"

In January 1994, the Council adopted a mission statement that clearly defined its purpose and modus operandi: "*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 improve the quality of life of all Canadians. NSERC fulfills its mission by awarding grants and scholarships through a competitive process and by building partnerships among universities, governments, and the private sector.*"

NSERC focuses on the university sector, the single most important source of scientific and technological knowledge in Canada. Universities play a vital role both 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 in these essential activities. Canada can take pride in the accomplishments of its research scientists and engineers. We have an international presence in all the important natural science and engineering fields; indeed, in several areas our researchers are the best in the world.

Research and research training in Canada, funded through NSERC, leads to many benefits. Research results lead to new or improved products and processes. Highly qualified young people, educated through research, know how to use new knowledge productively. New companies are established to take advantage of these advances, thus creating new jobs and adding to Canada's prosperity. Established companies use these advances to compete in the global market. Technological and scientific competence is maintained to ensure Canada's competitiveness, and to help Canadian companies to grow and meet new challenges. Indeed, in some areas (such as telecommunications) Canada already leads the world, aided in no small part by our university knowledge and training base.

NSERC is strongly committed to the development of a healthy science culture in Canada. Communication - with the research community and with the public - is a priority. In addition, the Council is taking steps to encourage NSERC-funded researchers to make their results and activities widely known in a way that the public will understand. Among other initiatives, NSERC's World Wide Web site *(http://www.nserc.ca)* contains a guide for researchers who wish to become involved in communicating with the public. In addition, in 1996-97, the Council

instituted a requirement that researchers submit brief "plain language" summaries of the research for which they are applying for funding; summaries of research approved for support will be posted on the web site. Success stories arising from NSERC-supported research are also available on-line.

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 are part-time, and receive no remuneration for their participation. The President is full-time, and functions as the Chair of the Board and the Chief Executive Officer of the Council. A chart showing details of the Council's organization is given in Section IV (Figure 10).

As one of the arm's-length agencies reporting to Parliament through the Minister of Industry, NSERC is a part of the Industry Portfolio. The federal science and technology strategy, *Science and Technology for the New Century*, released recently by the Minister of Industry and the Secretary of State for Science, Research and Development, 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 within the coherent strategy of the Industry Portfolio's *Action Plan*. Our programming, and our responses to the challenges currently facing both the agency and the university system in Canada, are all aimed in that direction.

2. The Planning Context: Challenges Facing NSERC and Canadian University Research

All NSERC's business is conducted within the context of increasing pressures on the university system in Canada. Perhaps the single most important challenge facing the Council at present is addressing the tension between the demand for funds in the universities, and the reductions to NSERC's budget mandated by Program Review I and II. Budget cuts announced in February 1995 and March 1996 will decrease NSERC's funding over the four-year period to 1998-99 by 16% relative to the previously-approved levels (Figures 1 and 2). It should be noted that, in line with the government's emphasis on science and technology, these reductions are less than those required of other areas of government.

Figure 1: Agency Overview

(thousands of dollars)	Main Estimates 1996-1997	**Main Estimates 1997-1998**	Planned 1998-1999	Planned 1999-2000
Total Main Estimates	449,626	**433,855**	409,389	403,566
Revenue credited to the Consolidated Revenue Fund	(60)	(60)	(60)	(60)
Estimated Cost of Services by Other Departments	1,732	**1,730**	1,730	1,730
Net Cost of the Agency	451,298	**435,525**	411,059	405,236

Figure 2: NSERC Budget 1990-1991 to 1999-2000

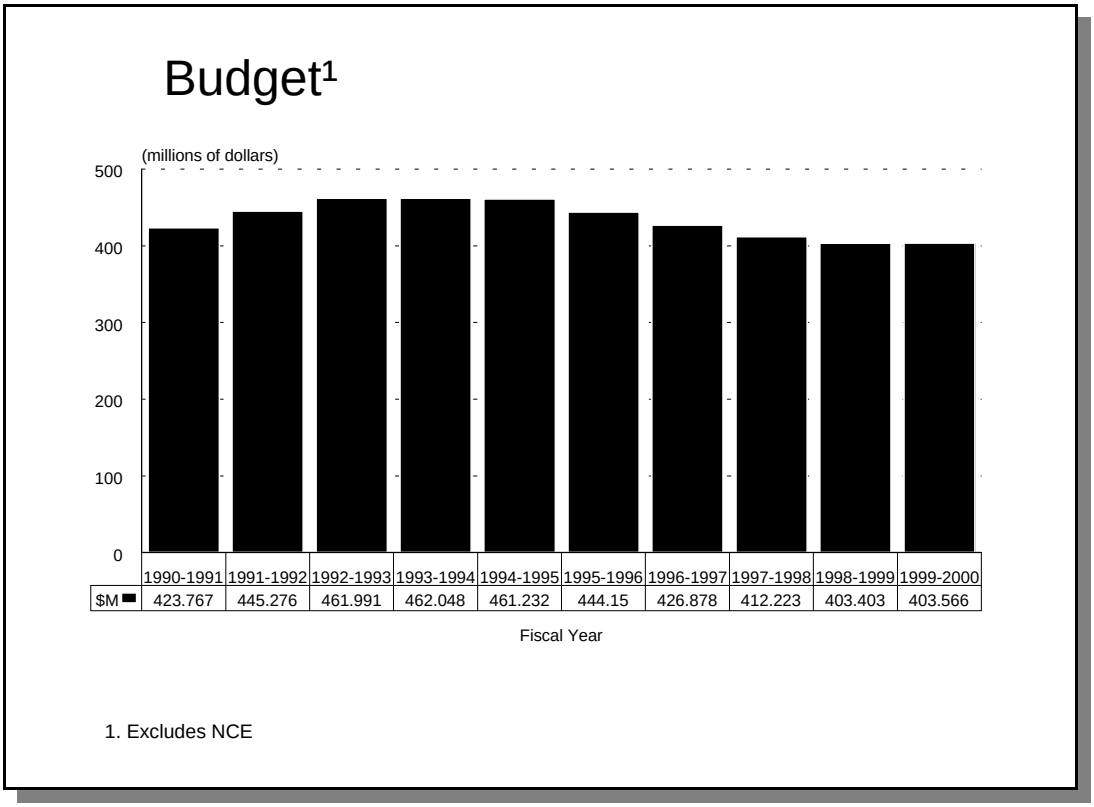
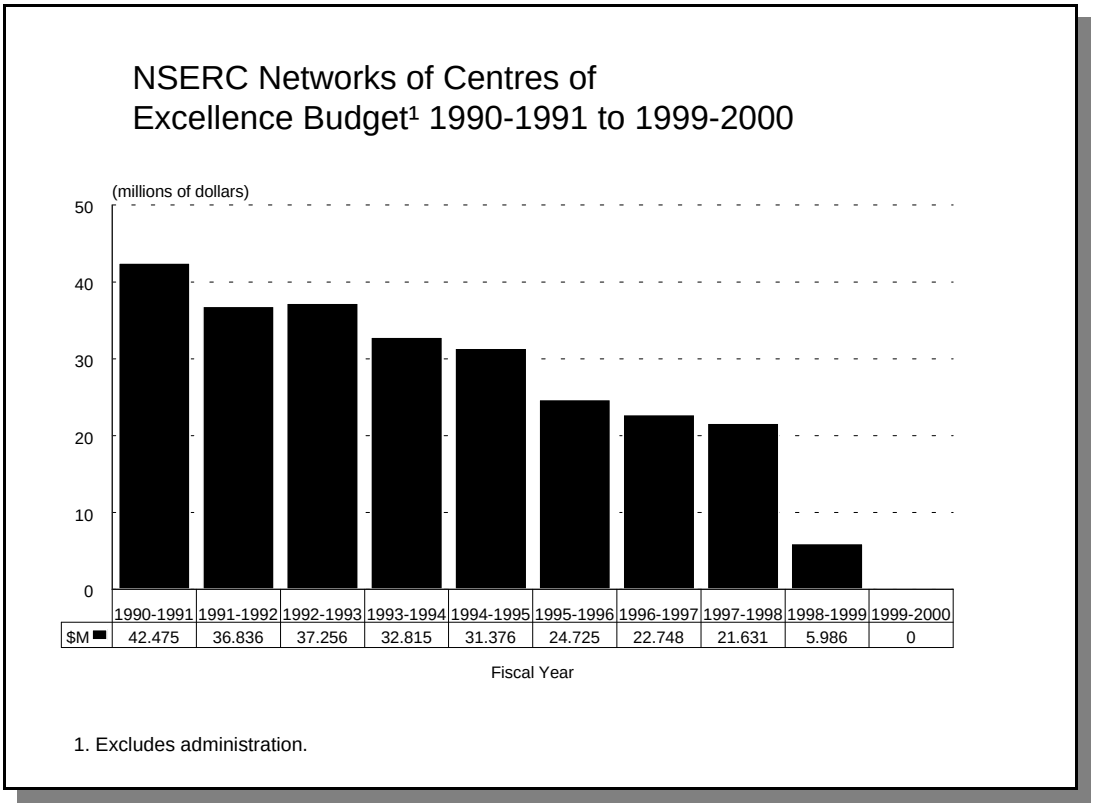


Figure 3: The Networks of Centres of Excellence Program, 1990-1991 to 1999-2000



It should be noted that the funding profile of Phase II of the NCE program should not be attributed to Program Review. Figure 3 shows the NSERC component of the NCE program budget since its inception.

It must be stressed that NSERC's funding provides only the ***direct*** costs of the research - that is, materials, laboratory supplies, graduate student stipends, and so on. The direct support provided by NSERC accounts for approximately one-half of the overall cost of the research programs and projects being funded by the Council. The salaries of professors who conduct the research, university infrastructure and operational costs, and other research overheads, are provided by the universities.

The decline in universities' budgets and in their ability to meet overhead costs is leading to pressure on researchers to use their NSERC grants to pay indirect research costs formerly covered by the universities. It is clear that NSERC cannot possibly fill the emerging funding gap. If Canadian research is to maintain its strength, all levels of government, and other sectors, must work together to protect the nation's investment in its future.

Finally, it should be noted that all NSERC-supported research takes place in the universities. The Council does not fund research in the private sector, nor does it fund research in other government departments and agencies. However, partnership with the private sector, and with

other agencies and levels of government, is of growing importance in the support of university research. Strengthening these partnerships, and building new ones, is another important challenge for the Council.

That being said, research in partnership with the private sector presents challenges of its own: specifically, building mechanisms which enable technology transfer, and dealing with the issues of commercialization and the ownership of intellectual property. NSERC retains no interest in any intellectual property developed using NSERC funding. The return to the government on investments made through NSERC is in the form of enhanced economic activity. To that end, the guidelines of NSERC's Research Partnerships (RPP) program state that "*The partners and other potential users* [of the research results] *must have the capacity to apply the research results in Canada. If not, a plan to develop or create an appropriate receptor capacity for the research results must be an integral part of the proposal.*" The guidelines also recommend that "*... the partner organizations) and the university(ies) involved in an RPP proposal negotiate a research agreement before starting the research project.*" In addition, the guidelines state that "*NSERC may require that the university and the company reach an agreement on the disposition of intellectual property as a condition of an award.*" This allows NSERC to be confident that intellectual property developed with NSERC support will be commercialized for the benefit of Canada.

NSERC's planning process is designed to meet the challenges discussed above, in the context of its declining budget and the changing university system. Resources are being concentrated on the core functions of support for basic and project research, and advanced training. NSERC's goals are being achieved through a focus on activities central to the Council's mandate and mission, and by ensuring that programming and policies are flexible, adaptable, and appropriate, able to deal with challenges, and anticipate and take advantage of the rapid pace of change in the universities.

Accountability is a core concern in all of NSERC's programs and processes. NSERC is engaged in the development of performance indicators, and performance measurement frameworks, for all its activities. These indicators and measurement frameworks will allow the Council to ensure that its programming achieves its objectives, and to assess the contribution made by NSERC programming to the overall national innovation system; they are discussed further in Section III of this document.

3. NSERC's Activity Structure

NSERC is organized around two Activities, ***Grants and Scholarships***, and ***Administration***. The Grants and Scholarships activity supports three sub-activities:

- basic research, supported by grants to university researchers;
- project research, supported through university-industry partnerships; and
- the advanced training of scientists and engineers, supported both directly by scholarships and fellowships, and indirectly through grants to professors.

These subactivities provide strong support to the government's stated goal of advancing knowledge: as *Science and Technology for the New Century* puts it: "*the goal* (is) *to create in Canada world centres of excellence in scientific excellence; to build a broad base of scientific enquiry; to foster Canadian participation in all major fields of science and technology; and to ensure that new knowledge can be acquired and disseminated widely, from Canadian sources and from around the world."* NSERC is an essential contributor to this effort.

The Administration activity provides management and administrative support to the Grants and Scholarships Activity.

Further details of NSERC's activities and sub-activities are found in section C.

4. NSERC's Programming and Funding

NSERC's programming is developed in consultation with the Canadian research community, in the context of the challenges facing the Canadian university research system, now and in the future, and in light of Canada's needs and government policy, including the S&T Strategy and the Industry Portfolio Science and Technology Action Plan. NSERC funding is awarded through a rigorous process of peer review, a process that can be usefully compared to stringent quality control (a more detailed description of the peer review process can be found in Section IV). 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; the Council's staff are expert in administering the process of peer review of applications for grants and scholarships.

Applications for research funding - basic and project - are judged first and foremost on the merits of the proposed science or engineering research, and on the stature 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 a suite of 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. It should also be noted that, in addition to those receiving direct Scholarships and Fellowships support, many other students receive support from research grants awarded to faculty supervisors; approximately the same amount goes to students via this route as via direct student support programs.

Figure 4 shows the distribution of NSERC funding among its subactivities for the period 1990-91 to 1999-2000. Council believes that basic university research is crucial to Canada's continued prosperity, and has taken steps to protect that funding envelope. (It should be noted when reading this Figure that the distribution of funds for the years 1998-99 and 1999-2000 is notional only, and has yet to be approved by NSERC's Council.)

Figure 4: NSERC's Operational Plan, 1990-91 to 1999-2000

NSERC Expenditures

(millions of dollars)

	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000
Research Grants Programs	252.9	264.6	271.3	267.9	277.2	263.1	256.6	248.0	241.6	243.1
Research Partnerships	120.7	120	124.8	121	116.2	119.1	114.4	110.1	94.4	87.7
Training	64.9	70.9	76.4	78.1	73	67.6	60	57.9	56.1	55.4
General Support	10.4	10.3	10.1	9.7	8.6	2	1.7	1.2	1.2	1.2
GRANTS AND SCHOLARSHIPS	448.8	465.8	482.7	476.7	475	451.9	432.7	417.2	393.3	387.4
Administration	17.4	16.3	16.6	18.1	17.6	17	16.9	16.7	16	16.2
TOTAL EXPENDITURES	466.2	482.1	499.2	494.9	492.6	468.9	449.6	433.9	409.4	403.6

Information regarding specific NSERC programs, as well as eligibility guidelines and other regulations, may be found on our Web site.

C. Details by Activity and Sub-Activity

1. Grants and Scholarships

Although all are focused on university-based research, and all operate in the context described above, the three sub-activities of the Grants and Scholarships activity have differing attributes and goals. The first, **basic research**, can be described as follows:

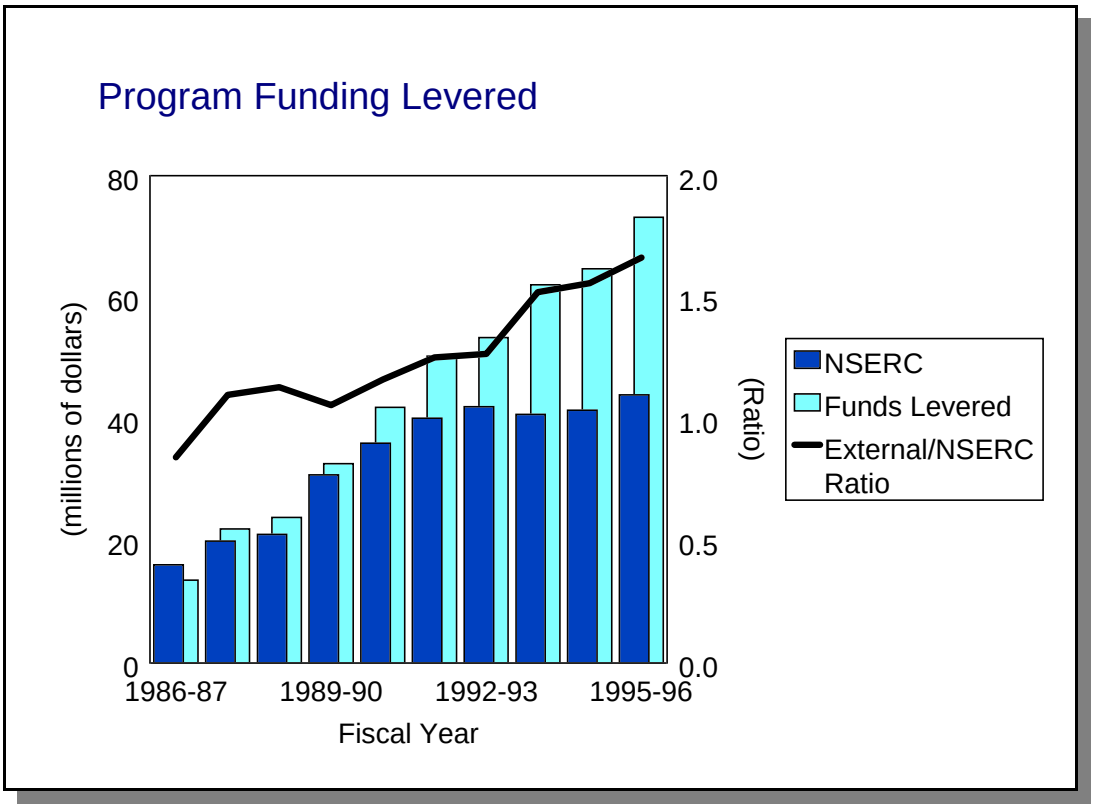
- its object is discovery;
- the research program is defined by the researcher or research team;
- merit is judged through a process of peer review, in terms of its potential to influence the direction of the field;
- it provides students with advanced training, teaching them to generate new knowledge and to understand knowledge's trends and limitations;
- results are peer-reviewed, and published openly, without delay;
- results may lead to profound, and unpredictable, long-term social and economic benefits;
- its short-term economic benefits, if any, are incidental and their presence or absence do not skew either the funding or the policies of research support; and
- it provides the pool of knowledge for possible future benefits and applications.

The attributes of **project research** are as follows:

- its object is to achieve a specific, more-or-less foreseeable result, in an area related to industrial activity;
- it takes place as a project, with a format and schedule defined by the university investigators and their partners;
- its economic benefits are sufficiently short-term to encourage partners from industry and other sectors to invest their own resources in the project;
- its merit is judged in terms of the quality of the proposed research, the design of the proposed project, and the proposed contribution from the partners;
- although it requires all parties to agree on matters such as technology transfer and the attribution of intellectual property, the open publication of the research results may be somewhat delayed, to allow time to patent or otherwise protect the resulting intellectual property, but any portion of the work being done by students must meet the university's academic requirements for a degree; and
- it often provides training which is an immediate benefit for the industrial partner - the graduate students and research staff working on it can be employed immediately by the partner at the end of the project.

Project funding requires active participation from the non-university partner, in the form of a financial contribution and, in many projects, involvement in the setting of the research priorities and objectives, participation in the research, in the management and communication of the project, or in the exploitation of the results. The financial contribution itself may be cash, or in-kind, through the provision of staff, facilities, or other resources. This approach has proven very successful in levering resources into the universities for research: at present NSERC's University-Industry programs levers approximately $1.60 from other sectors, mainly the private sector, for every $1 of NSERC project funding (see Figure 5).

Figure 5: NSERC's Leverage



The third sub-activity, the **advanced training of scientists and engineers**, takes place through two mechanisms: direct provision of scholarships and fellowships to Canadian students, and payment of stipends to students and postdoctoral fellows from research grants (basic and project) awarded to university faculty members. This training:

- provides Canada and Canadian industry with the trained people they need to compete in the global marketplace;
- provides Canadians with the training and expertise needed to take advantage of technological and scientific discoveries and advances made in Canada and abroad;

- ensures Canada has the capacity to use new knowledge productively, and adds value to Canadian research within Canada; and
- assists students and research staff to experience research problems and methods in other sectors.

In addition to making an important contribution to Canada's overall economic well-being, the advanced training business line can make an enormous difference to the lives of individual Canadians. A survey of former holders of NSERC scholarships is discussed in Section III.

2. Administration

The Administration activity supports all operations of Council and its committees, and manages the administration of grants, scholarships, and fellowships; it includes the Human Resources, Finance, Administration, and Information Management and Systems functions.

A. Summary

NSERC is addressing the need to ensure that all federal programming provides a return on investment by developing a series of performance measures ("indicators") for each of its three Grants and Scholarships sub-activities. These indicators will recognize the inherent differences among basic research, project research, and training, and the need for both short-term and longer-term indicators. The following section discusses some of the issues which must be addressed in the development of performance measures, and outlines the present state of their development at NSERC.

The Council is also developing measurements for its Administration activity to ensure that these activities are useful and efficient, and that the Council provides quality service to its clientele.

B. Overview of Performance Measurement Issues

NSERC's business is the support of the whole spectrum of university-based research. Evaluating the performance of programs that support research is at an early stage in all countries; our contacts with similar councils abroad lead us to conclude that we are in the vanguard of developing appropriate measures, as compared with our international colleagues. It should be noted that NSERC's performance measurement effort is focused on evaluating the **programs** of research and training support, not the actual research that is funded. The latter is evaluated rigorously through peer review when any application for new funding is received, as well as through project reviews in the case of project research. Council evaluates its programming to ensure that it is meeting its objectives, and that these objectives continue to be relevant to Canada's needs and those of Canada's university researchers. These two areas of evaluation overlap to some extent, but the distinction is important and must be kept in mind to ensure that the results of the evaluation process are clear and useful.

The most important factor to remember when developing performance indicators for assessing research support programs, is that in general these investments take longer to bear fruit than most other government investments. This longer time-scale is illustrated in the following box.

Canola is Canada's second most valuable crop (after wheat), and a well-established Canadian research success. But the researchers who initially developed Canola probably didn't expect that it would be applied to the manufacture of high-value chemicals and pharmaceuticals. Dr. Maurice Moloney, a world leader in plant biotechnology, and his team at the University of Calgary, are doing precisely that.

With the help of NSERC funding, Dr. Moloney and his team are creating types of Canola which can produce useful proteins in an easily-extracted form. So far they have developed a form of rapeseed - a close relative of Canola - that produces the anticoagulant hirudin, and the anti-cancer drug interleukin-1. As well as producing a variety of industrial and food enzymes, they are also collaborating with other NSERC-funded researchers to develop a fish feeding-enhancer for use in aquaculture.

The group has formed a spin-off company, SemBioSys Genetics Inc., to commercialize their work, and they have applied for several patents. Dr. Moloney recently received a notification of allowance from the US Patent Office on the first of these. He attributes their success to their background research in gene expression, saying that "Every 'applied' project requires essential information derived from ten or more 'basic' projects."

Performance measures for university research are of two types: *output measures,* and *outcome measures. Outputs* are the immediate results of the research: published papers, citations of those papers, patents, product and process innovations, trained people, and so on. *Outcomes* are the longer-term results of these results: new insights into natural processes, increased productivity, new or revitalized industries, improved social, regulatory, and economic policy making, and social and economic advances in general. It will be recognized that *outputs* are far easier to measure than *outcomes,* while in the long term outcomes - the *impact* of the research - are (or can be) far more important. It is therefore more informative, in terms of determining the return on the research investment, to measure the *outcomes* of the research, rather than simply the *outputs,* although measuring the outputs is also necessary to provide credibility to the outcomes being claimed. Of course, it is also more difficult to measure outcomes.

As might be expected, measuring the performance of programs which support research undertaken in partnership with private and government-sector participants is somewhat more straightforward than measuring that of basic research support programs. This must not, however, be taken as an indication that partnership research is a "better investment" than basic research. They serve different purposes: basic research forms the foundation on which projects and partnerships are built, while partnership research provides the opportunity to develop intellectual links among the sectors, and to transfer the results of basic research to the eventual developer of applications. The impossibility of predicting **which** line of basic research might eventually develop into a partnership opportunity means that it is vital to support a broad spectrum of basic research, as well as provide mechanisms to develop partnerships between the universities and the

private sector. The crucial task is to find the right balance between the two. This balance is constantly shifting, presenting all those who support research with a continual challenge, and a continual need to assess and re-assess the relative effort put into basic and project research. Council has recently addressed this balance, and stated its belief in the importance of basic research, by deciding that the funding for its basic research business line would be protected from cuts to the Council's budget.

The research spectrum is illustrated by the growth of Handy Chemicals, discussed in the following box.

Concrete superplasticizers are additives that allow concrete to be made with a very low water content. This increases its strength and durability, and reduces replacement and repair costs. Fifteen years ago, Japanese manufacturers had cemented the market for concrete superplasticizers. Today an innovative Canadian company has a firm foundation in this market, thanks to the skill of two researchers, and its own foresight and nerve.

In 1980, Handy Chemicals, based in La Prairie, Quebec, decided to enter the competitive world of superplasticizers. Realizing that they lacked the know-how and facilities to develop a marketable product, the company formed an alliance with Drs. Carmel Jolicoeur and Pierre-Claude Aïtcin, at the University of Sherbrooke. Dr. Jolicoeur is a colloid chemist; Dr Aïtcin is a civil engineering specializing in concrete. Dr. Jolicoeur's knowledge of the chemistry, combined with Dr. Aïtcin's applied engineering skills have produced a product that can -- and does -- sell.

Today Handy is one of the largest producers of concrete superplasticizers, with exports accounting for 60% of their business. The company has hired 60 new staff, many of them with advanced training. Their product was used in building the new "fixed link" - Confederation Bridge - between New Brunswick and Prince Edward Island.

In recognition of their achievement, the partnership between Handy and Drs. Jolicoeur and Aïtcin was recognized with a *Synergy Award* from NSERC and The Conference Board of Canada.

The next section describes NSERC's performance measurement activities, and their progress to date, by activity.

C. Details by Activity

1. Grants and Scholarships

a. Basic Research

The primary objective of this subactivity is the promotion of significant Canadian discoveries in important areas of the natural sciences and engineering. NSERC invests across the entire spectrum of natural science and engineering research. This broad investment, and its long-term payoffs, present significant challenges in performance measurement and program evaluation. It must be remembered that the outcomes of basic research are often realized in the longer term, often years or decades after the original research was performed. Measurement is further complicated by the natural integration of many streams of basic research into the eventual outcome, a process illustrated in the following box.

> For decades, researchers have looked for an effective way to deliver vaccines orally. Oral vaccines are easier to store, transport, and administer than vaccines requiring injection, and are believed to be more effective against some diseases. The major problem with them is that the vaccine must be protected from the hostile environment of the digestive system - oral vaccines are destroyed by powerful stomach acids before they can be absorbed into the body through the intestines.
>
> Now years of basic polymer and silicone chemistry could revolutionize the delivery of vaccines. Dr. Michael Brook, from McMaster University in Hamilton, working with Connaught Laboratories in a partnership funded by NSERC, Connaught, and the Ontario University Research Incentive Fund, has developed a technique in which starch microtubules are bonded to the vaccine, then the whole is coated with silicone. Preliminary tests have shown that the technique is effective, although it must still be proven to be commercially viable, and undergo clinical tests. The team estimates that it is about five years away from the marketplace.

Measuring the performance of NSERC's programs which invest in basic research is at an early stage, but some progress has been made. NSERC is developing a suite of indicators that will link these investments to impacts on Canada's economy and social well-being. An interim report on the development of these indicators will be presented to Council in June 1997; an outline of the interim report's discussion is presented in Section IV - 7. A table of prospective indicators is given in Figure 6; the full suite of indicators is expected to be in place by the 1999-2000 fiscal year.

Figure 6: Measuring the ***Basic Research*** Programs' Performance

Main Goal:	**Outcomes:**	**Prospective Indicators:**
To promote significant Canadian discoveries in important areas of natural sciences and engineering	▪ High quality research capability maintained across all areas of natural sciences and engineering ▪ More knowledge available for product and process innovation ▪ Knowledge base for developing policies and regulations, and making decisions, for government and industry ▪ Highly qualified personnel to meet the needs of industry and the public sector ▪ Optimized use of university- based research facilities ▪ Better ability to use new knowledge from around the world	▪ Size and distribution of grants ▪ Distribution of funds among disciplines ▪ Expenditures on student stipends ▪ Levering of funds from other sources ▪ Publications - number and impact ▪ New "emerging" areas ▪ Training of highly qualified people ▪ Patents, licences ▪ Awards and prizes to Canadian researchers and students ▪ Spin-off companies ▪ Impact on public policy

b. Project Research

The aim of project research is to solve problems which require new knowledge for their solution, particularly but not exclusively in the private sector. The desired outcome is the productive use of new knowledge in the economy and in society.

As for the basic research sub-activity, NSERC is developing a suite of indicators for its investments in project research. These indicators are closer to completion than those for basic research, and it is expected that the final suite will come into use during 1997-98. A table outlining the prospective indicators is given in Figure 7.

Figure 7: Measuring the ***Project Research*** Programs' Performance

Main Goal:	**Outcomes:**	**Prospective Indicators:**
To facilitate knowledge transfer from universities to other sectors, and the commercialization of university-derived technologies	▪ Creation and productive use of knowledge in support of new products, processes, services, policies, standards and regulations in private and public sectors *Contribute to:* ▪ Wealth creation and improving the quality of life in Canada ▪ More high value-added economic activity in all sectors ▪ Canadian companies' success in the global market ▪ Canadian companies become more innovative ▪ More students exposed to non-academic research environments ▪ Generation of good jobs ▪ New technologies giving Canadian business a market advantage ▪ Canada becomes more attractive to foreign investors	▪ Number of licenses, patents, spin-off and start-up companies ▪ Number of inter-sectoral research projects ▪ Number of companies involved in research collaboration with universities ▪ Number of highly qualified personnel supported in collaborative projects ▪ Satisfaction surveys of research partners ▪ Total funds from external sources, and percent levered ▪ Total funds from private sector and percent levered ▪ Employment of graduates ▪ New Canadian science-based products introduced to the market

c. Training

Measuring NSERC's performance in the training of highly qualified personnel is perhaps the most straightforward of the evaluation challenges facing the Council. The outputs - numbers of people with advanced knowledge and technical skills - are easily measured, and their impact on the economy and on society is important in both the short and long term.

One important measure that the Council uses is the "employability" of those with advanced degrees; this is determined through an annual survey of former holders of NSERC Postgraduate Scholarships (PGS). The most recent version of this study showed that the majority of those who received NSERC scholarships are making their careers in research or technology fields, and that they have an employment rate of approximately 98%. (This includes approximately 10% in post-doctoral studies, and approximately 5% employed as research assistants or research associates.) Further details of this study may be found in Section IV; the full study can be obtained from NSERC.

A table of prospective indicators for the training business line is given in Figure 8.

Figure 8: Measuring the ***Advanced Training*** Programs' Performance

Main Goal:	**Outcomes:**	**Prospective Indicators:**
Strengthen research and industry by developing Canada's S&T human resources	▪ Improved supply/demand balance for highly qualified personnel ▪ Training of students and new researchers in academic, private sector, and government laboratory environments ▪ Greater acceptance of graduates in a variety of roles in industry, and as "knowledge entrepreneurs" ▪ Greater job satisfaction and employee productivity since trained employees are challenged to use their skills ▪ Stronger economy due to more technology transfer via highly trained employees in the public and private sectors, as well as due to the creation of new businesses by trained individuals	▪ Number of people funded by NSERC hired by private sector, public sector, and university system ▪ Participation rate of companies (especially small and medium sized enterprises, SMEs) in NSERC industrially-oriented training programs ▪ Number of participating companies and SMEs ▪ Number of students trained in SMEs ▪ Client company satisfaction surveys ▪ Remuneration trends for natural science and engineering graduates in Canadian industry ▪ Employment statistics for trained people ▪ Reduced need for recruiting offshore, because Canadians with the required advanced skills are now available

2. Administration

NSERC is also addressing performance issues in its Administration activity. Among these are quality service initiatives, communications, and increasing the representation of women in natural science and engineering fields. A table showing these issues, the expected outcomes of achieving success in them, and progress to date, is shown in Figure 9.

Figure 9: Administration Performance Issues

Initiative	Expected Outcome(s)	Progress to Date
Quality service standards oriented to external clients	▪ Improved service to NSERC clients in all sectors ▪ More efficient use of funds	Standards have been established for: responding to and ruling on questions relating to post-award eligibility of expenses, resolution of questions relating to ownership and transfer of equipment purchased with NSERC support, and responding to questions regarding software for electronic applications. Work continues in other areas In the Communications area: ▪ NSERC convened a National Workshop on the Needs of the Next Generation of Canadian Researchers to receive advice from this important group. A comprehensive set of recommendations was developed, which is now being reviewed for possible implementation in 1997. (for more information see section 8.2) ▪ A major conference organized by NSERC in collaboration with the Conference Board of Canada brought over 200 people to examine best practices in university-industry collaboration. ▪ NSERC's Web site is now a major vehicle for communicating with clients and the public. News releases are posted immediately; program changes, new program descriptions and program cancellations are normally posted before the material is mailed to the universities. NSERC's newsletter is available electronically the day that it receives final approval from NSERC's President; back issues are also available. Electronic forms and relevant information can also be downloaded
Replace paper forms and management by their electronic equivalents	▪ Reduced forms and forms management costs ▪ Faster processing of applications ▪ Decreased turn-around time ▪ Better filing system	▪ Full implementation of new computer system delayed until Spring 1997 due to changes in program and administrative requirements ▪ Pilot test of common software package has been completed - percentage of use ranged from 25% to 50% of applicants. Testing of electronic transfer of applications will be undertaken before the end of 1996-97
Establish common administrative services with Social Sciences and Humanities Research Council (SSHRC)	Improved service to internal and external clients of both agencies	▪ Common Administrative Services Directorate consolidated during 1996-97 ▪ Classification and staffing of all positions in Administration, Human Resources, and Finance completed December 1996 ▪ Information Management and Systems will be integrated in 1997-98

Global payments system for scholarships	▪ More efficient administration ▪ Better service to students	▪ Universities consulted on proposed system ▪ Harmonization between NSERC and SSHRC scholarship payment procedures underway ▪ Implementation of new system delayed until April 1998 due to delay in implementing new electronic awards management system at NSERC
Explain what NSERC supports, why it is important, and how NSERC is accountable	Contribute to: ▪ Increased awareness of the value of university-based research among the public and opinion leaders in the public and private sectors ▪ Increased science literacy ▪ Increased awareness of the return to Canada from its investment in S&T via NSERC	▪ There are over 50 success stories posted on NSERC's website under "Great Research for Canadians" ▪ This year NSERC published the results of its Spring grants and scholarships competitions within a few days of the announcement of the awards. This is the earliest that results have been available electronically. ▪ All applicants are now required to provide a public summary of their research. This decision has received wide positive comment in the scientific and national press. ▪ NSERC has published an electronic guide (*Communicating Science to the Public: a Researcher's Handbook)* to assist researchers in their public communications activities.
Better access to information for users of NSERC's programs	As for previous initiative	See previous initiative and Quality Service Initiatives
Assist in increasing the participation of women in science and engineering	▪ More women in science and engineering careers ▪ More women faculty members in science and engineering departments at Canadian universities ▪ Increased rate of participation by women in NSERC programs	▪ Decision taken by Council on recommendations of Task Force on Women in Science and Engineering - June 1996 ▪ Council to implement decisions by June 1997

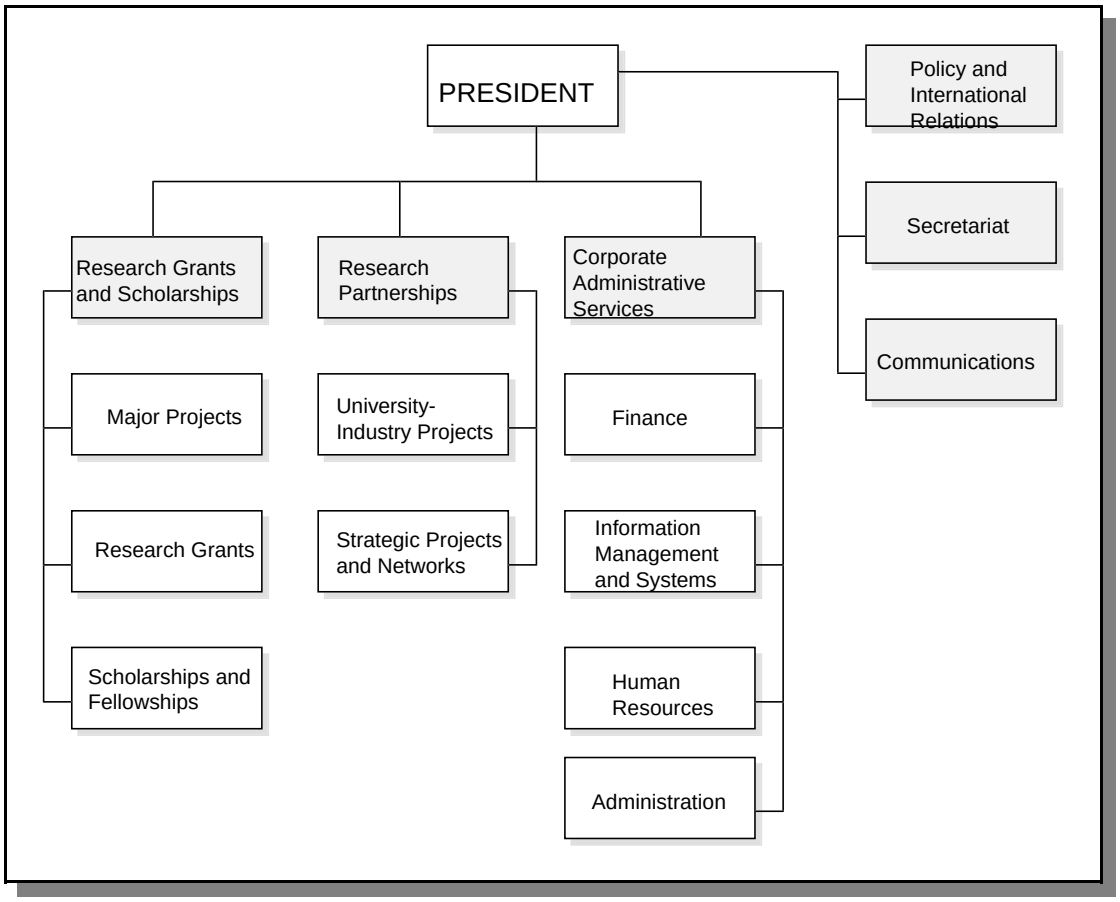
Section IV: Supplementary Material

1. Organization

1.1 NSERC's 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. The various directorates and divisions are subdivided as shown in Figure 10.

Figure 10: Organization of Council Staff



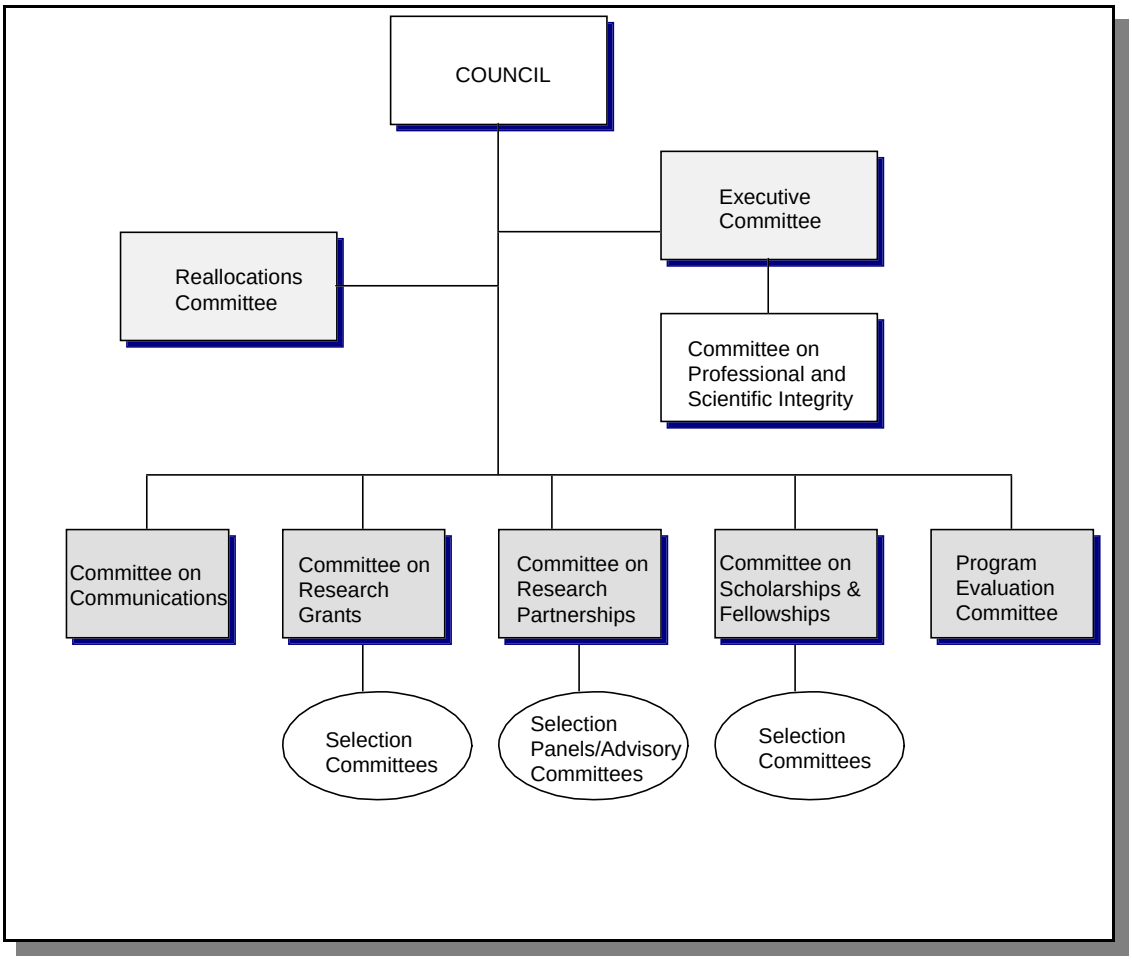
1.2 NSERC's Standing Committees

Council is advised on policy and programming matters by several Standing Committees. In the intervals between full meetings of Council, policy matters requiring Council input are handled by the Executive Committee, composed of the Vice-President and the Chairs of the Committee on Research Grants, the Committee on Scholarships and Fellowships, the Committee on Research Partnerships, and the Committee on Communications, as well as other Council members. The Reallocations Committee meets periodically to determine the allocation of funds among the various discipline-based selection committees in the Research Grants program. The Program Evaluation Committee is responsible for advising Council on matters relating to program evaluation, performance measurement, and indicators. The Committee on Professional and Scientific Integrity is a sub-committee of the Executive Committee, and advises Council on matters related to integrity and research ethics. The committee structure is given in Figure 11.

Council continually reviews current expenditures and future allocations for each of NSERC's programs. In the fall of each year Council prepares preliminary program budget allocations for the upcoming fiscal year, which it approves at its annual January meeting. Council also in the all prepares a tentative program allocation for the next three years, including the upcoming fiscal year.

Committee members are drawn from across the research community, and include industrial, academic, and government researchers as well as students. Members of committees, whether standing committees or selection committees, serve without remuneration.

Figure 11: NSERC's Standing Committees



Council allocates program funding at a high level, and it is the responsibility of its advisory committees and NSERC management to control the budgeting by discipline or committee for all programs, and also manage the budgets for other smaller programs. These allocation methodologies vary by program, and a brief description for some of the major programs follows:

♦ Research Grants - The allocation process for NSERC's largest program is managed on a four-year cycle based on a review known as the "Reallocations Exercise." Every four years the budget allocations for discipline-based committees, known as "Grant Selection Committees," are determined through a review of the discipline's contributions to Canadian science and engineering research and training. The overarching criterion for reallocation of support is the potential importance to Canada; submissions must explain "Why is it important for Canada that your research community should receive some of the funds available for reallocation?" Resources will be redirected to areas of high impact and need as compared to the resources required for other disciplines. This reallocation ensures the optimal use of scarce

funding. A more detailed description of the Reallocations Exercise can be found on the NSERC Web page.

♦ Strategic Projects - The following research areas have been targeted for acceleration by Council under the Strategic Projects component of the program until 1999: Biotechnologies, Energy Efficiency Technologies, Environmental Technologies, Information Technologies, Manufacturing and Processing Technologies, and Materials Technologies. Although the program accepts applications from all natural science and engineering disciplines, the competition budget will be allocated so that applications in these targeted research areas have a higher chance of being funded than those in the non-targeted areas.

♦ University-Industry Projects - After extensive peer review and negotiations with the industrial or government partners, applications are adjudicated by a review committee, and awards are made based on the committee's recommendation. The success rate of University-Industry applications varies by the suite of programs within the area, but is overall roughly seventy percent. The suite of programs within university-industry projects is responsive to, and driven by, industry's needs, industry being in the best position to adopt and utilize the sponsored university research.

♦ Scholarships and Fellowships - NSERC postgraduate scholarships and postdoctoral fellowships are allocated by discipline, based on an analysis of the supply/demand situation for these highly qualified people. Resources are once again redirected to disciplines where there is a relatively high demand for personnel as compared to the supply.

1.3 Resource Requirements

1.3.1 Authorities for 1997-1998 - Part II of the Estimates

Financial Requirements by Authority

Votes (thousands of dollars)		**1997-1998 Main Estimates**	1996-1997 Main Estimates
	Natural Sciences and Engineering Research Council		
85	Operating Expenditures	**15,205**	15,603
90	Grants	**417,164**	432,737
(S)	Contributions to Employee Benefit Plans	**1,486**	1,286
	Total Agency	**433,855**	449,626

Votes - Wording and Amounts

Vote (dollars)		**1997-1998 Main Estimates**
	Natural Sciences and Engineering Research Council	
85	Natural Sciences and Engineering Research Council Operating Expenditures	**15,205,000**
90	Natural Sciences and Engineering Research Council The Grants Listed in the Estimates	**417,164,000**

Program by Activities

(thousands of dollars)	**1997-1998 Main Estimates**			1996-1997 Main Estimates
	Budgetary		**Total**	
	Operating	Transfer Payments		
Grants and Scholarships		417,164	**417,164**	432,737
Administration	16,691		**16,691**	16,889
	16,691	417,164	**433,855**	449,626

1.3.2 Use of 1995-1996 Authorities - Volume II of the Public Accounts

Vote (dollars)		Main Estimates	Total Available for Use	**Actual Use**
	Natural Sciences and Engineering Research Council			
80	Operating Expenditures	16,052,000	16,842,450	**15,803,064**
85	The Grants Listed in the Estimates	448,364,000	451,856,000	**451,856,000**
(S)	Contributions to Employee Benefit Plans	1,158,000	1,216,000	**1,216,000**
(S)	Symposium on Research and Development Impact		108,731	**108,731**
(S)	Spending of Proceeds From the Disposal of Surplus Crown Assets		3,189	**1,192**
	Total Program - Budgetary	465,574,000	470,026,370	**468,984,987**

1.3.3 Summary of Financial Requirements - Financial Requirements by Activity

(thousands of dollars)	**Estimates 1997-1998**	Forecast 1996-1997	Actual 1995-1996	Actual 1994-1995	Actual 1993-1994
Grants and Scholarships	**417,164**	432,737	451,856	474,995	476,725
Administration	**16,691**	16,889	17,129	17,535	18,138
	433,855	449,626	468,985	492,530	494,863
Human Resources (FTE)*	**191**	183	190	184	183

* See section IV, 2 for additional information on Human Resources

Explanation of Change: The decrease of $15.6 million in 1997-1998 grants and scholarships requirements over the 1996-1997 forecast is due primarily to reductions resulting from the 1994 Program Review. The $0.2 million decrease in operating budget expenditures is explained in section 4.2.2, "Explanation of Change."

Explanation of 1995-96 Actual: The 1995-1996 grants and scholarships forecast of $451.9 million is an increase of $3.5 million over the 1995-1996 Main Estimates of $448.4 million. The increase relates to the new networks of Phase II of the Networks of Centres of Excellence program. The $18.0 million operating forecast is an increase of $0.8 million over the 1995-96 Main Estimates of $17.2 million. The increase is attributable to the 1994-1995 carryforward allowable under the Operating Budget regime.

2. Personnel Requirements

The Program's personnel costs of $10.2 million account for 2.26% of total expenditures. A profile of the Program's personnel requirements follows.

2.1 Details of Personnel Requirements

Summary by Professional Category (FTEs)*

	Actuals 1994-1995	Actuals 1995-1996	Main Estimates 1996-1997	Main Estimates 1997-1998	Planned 1998-1999	Planned 1999-2000
GIC Appointment	1	1	1	1	1	1
Executive Group	14	11	10	11	11	11
Administrative and Foreign Services						
Services	34	39	35	43	43	43
Computer Systems	20	20	19	19	19	19
Personnel Administration	3	3	3	4	4	4
Program Administration	40	39	40	39	39	39
Administrative Support						
Clerical	59	65	65	64	64	64
Secretarial	13	12	10	10	10	10
	184	190	183	191	191	191

[1] This includes all those at the DM level and all GICs

[2] This includes all those in the EX-1 to EX-5 range

[3] The difference in FTEs between the Actual 1995-1996 consumption and the estimated 1996-1997 consumption is due to an under-estimation of FTE requirments for 1995-1996 main estimates. It is expected that actual FTE consumption in 1996-1997 will be approximately 190.

* Note: Full-Time Equivalent (FTE) is a measure of human resource consumption based on average levels of employment. FTEs are not subject to Treasury Board control, but are disclosed in Part III of the Estimates in support of personnel expenditure requirements specified in the Estimates.

3. Capital Projects: NSERC does not undertake capital projects.

4. Additional Financial Information

4.1 1995-1996 Financial Performance

(thousands of dollars)	1995-1996		
	Actual	Main Estimates	**Change**
Grants and Scholarships	451,856	448,364	**3,492**
Administration	17,129	17,210	**(81)**
	468,985	465,574	**3,411**
Human Resources (FTE)*	190	183	**7**

* See table 2.1 for additional information on Human Resources

Explanation of Change: The 1995-1996 grants and scholarships expenditures were $3.5 million higher than the Main Estimates due mainly to Phase II of the NCE Program.

4.2 Activity Resource Summary

4.2.1 Grants and Scholarships

(thousands of dollars)	**Estimates 1997-1998**	Estimates 1996-1997	Actual 1995-1996	Actual 1994-1995	Actual 1993-1994
Grants	**337,622**	347,934	359,331	370,658	365,761
Scholarships and Fellowships	**57,911**	62,055	67,800	72,961	78,149
	395,533	409,989	427,131	443,619	443,910
Networks of Centres of Excellence	**21,631**	22,748	24,725	31,376	32,815
Total	**417,164**	432,737	451,856	474,995	476,725

4.2.2 Administration

(thousands of dollars)	**Estimates 1997-1998**	Estimates 1996-1997	Actual 1995-1996	Actual 1994-1995	Actual 1993-1994
Administration	**16,691**	16,889	17,129	17,535	18,138
FTE*	**191**	183	190	184	183

* Full-time equivalent (FTE) is the measure of human resources under the Operating Budget concept, which includes the withdrawal of Treasury Board controls over human resource consumption. FTE factors out the length of time that an employee works during each week by calculating the rate of assigned hours of work over scheduled hours of work.

Explanation of Change: The decrease in 1997-1998 Main Estimates administration costs of approximately $0.2 million over the 1996-1997 Estimates results from the following:

	(thousands of dollars)
Federal Budget Reductions	261
Funding of Technology Partnerships Program Completed	135
Salary Increment Freeze	54
Other Adjustments	3
Distribution of Translation Envelope	1
Adjustments to Employee Benefit Plans	(203)
Phase II of the NCE Program	(53)
Total Decrease	198

4.2.3 Financial Performance 1995-1996

(thousands of dollars)	1995-1996		
	Actual	Main Estimates	Change
Administration:			
$	17,129	17,210	(81)
FTE	190	183	7

4.2.4 Ratio of Administration Expenditures to Total Program Expenditures

(millions of dollars)	**Estimates 1997-1998**	Estimates 1996-1997	Actual 1995-1996	Actual 1994-1995	Actual 1993-1994
Total Program Expenditures	**433.8**	449.6	469	492.5	494.9
Administration Expenditures	**16.7**	16.9	17.1	17.5	18.2
Percentage of Total	**3.8**	3.8	3.6	3.6	3.7

Performance information and resource justification: Administration costs have varied in a limited range since 1993-1994. Every effort will be made to maintain administration costs at 3.8% of the total budget in 1997-1998.

4.3 Profile of Program Resources

4.3.1 Details of Financial Requirements by Object

(thousands of dollars)	**Estimates 1997-1998**	Estimates 1996-1997	Actual 1995-1996
Personnel			
Salaries and wages	**8,738**	8,867	8,603
Contributions to employee benefit plans	**1,486**	1,286	1,216
Subtotal	**10,224**	10,153	9,819
Goods and Services			
Transportation and communications*	**2,153**	2,275	2,148
Information	**621**	750	800
Professional and special services	**2,296**	2,389	2,885
Rentals	**128**	82	114
Purchase, repair and upkeep	**158**	188	151
Utilities, materials and supplies	**394**	335	614
Minor Capital	**717**	717	598
Subtotal	**6,467**	6,736	7,310
Total Operating	**16,691**	16,889	17,129
Transfer Payments	**417,164**	432,737	451,856
Total	**433,855**	449,626	468,985

* includes the transportation costs of the volunteer members of Council committees

4.3.2 Net Cost of the Program

The Estimates of the Program include only expenditures to be charged to the Program's voted and statutory authorities. Other cost items, as well as revenue, must be taken into account to arrive at the net cost of the Program. Details are provided in the following table.

(thousands of dollars)	**1997-1998**	1996-1997
Operating Expenditures	**16,691**	16,889
Grants and Scholarships	**417,164**	432,737
Main Estimates	**433,855**	449,626
Services Received Without Charge		
from Public Works and Government Services Canada	**1,168**	1,177
from the Treasury Board $8,867 x 5.7%	**507**	514
from the Office of the Auditor General	**40**	40
from Human Resources Development Canada	**15**	1
	1,730	1,732
Total Program Cost	**435,585**	451,358
Less: Revenues Credited Directly to the Consolidated Revenue Fund	**60**	60
Estimated Net Program Cost	**435,525**	451,298

4.3.3 Details of Expenditures in the Grants Vote

(thousands of dollars)	**Estimates 1997-1998**	Estimates 1996-1997	Actual 1995-1996
Research Grants	**248,002**	255,118	271,575
Research Partnerships	**110,053**	114,205	110,533
Training	**57,911**	62,055	67,800
General Support	**1,198**	1,139	1,948
Total	**417,164**	432,737	451,856

4.4 Appropriated Planned Spending

4.4.1 By Activity

(thousands of dollars)	Main Estimates 1996-1997	**Main Estimates 1997-1998**	Planned 1998-1999	Planned 1999-2000
Activities:				
Grants and Scholarships	432,737	**417,164**	393,340	387,354
Admininstration	16,889	**16,691**	16,049	16,212
Total	449,626	**433,855**	409,389	403,566

4.4.2 By Activities and Sub-Activities

(thousands of dollars)	Main Estimates 1996-1997	**Main Estimates 1997-1998**	Planned 1998-1999	Planned 1999-2000
Activities:				
Grants and Scholarships:				
Grants	347,934	**337,622**	331,222	331,222
Scholarships and Fellowships	62,055	**57,911**	56,132	56,132
Networks of Centres of Excellence	22,748	**21,631**	5,986	--
Administration	16,889	**16,691**	16,049	16,212
Total	449,626	**433,855**	409,389	403,566

4.5 Financial Requirements by Object

(thousands of dollars)	Actuals 1994-1995	Actuals 1995-1996	Main Estimates 1996-1997	Main Estimates 1997-1998	Planned 1998-1999	Planned 1999-2000
Personnel						
Salaries and Wages	8,875	8,603	8,867	8,738	8,409	8,549
Contributions to Employee Benefit Plans	1,104	1,216	1,286	1,486	1,430	1,453
	9,979	9,819	10,153	10,224	9,839	10,002
Goods and Services						
Transportation and Communications	2,394	2,148	2,275	2,153	1,991	1,991
Information	769	800	750	621	653	653
Professional and Special Services	2,217	2,885	2,389	2,296	2,173	2,173
Rentals	118	114	82	128	98	98
Purchased Repair and Upkeep	186	151	188	158	152	152
Utilities, Materials and Supplies	579	614	335	394	427	427
Minor Capital	1,293	598	717	717	717	717
	7,556	7,310	6,736	6,467	6,210	6,210
Total Operating	17,535	17,129	16,889	16,691	16,049	16,212
Transfer Payments	474,995	451,856	432,737	417,164	393,340	387,354
Total Expenditures	492,530	468,985	449,626	433,855	409,389	403,566

4. 6 Revenue Credited to the Consolidated Revenue Fund by Activity

(thousands of dollars)	Actuals 1994-1995	Actuals 1995-1996	Main Estimates 1996-1997	Main Estimates 1997-1998	Planned 1998-1999	Planned 1999-2000
Administration	43	196	10	10	10	10
Grants and Scholarships	118	199	50	50	50	50
Total Credited to the CRF	161	395	60	60	60	60

5. Statutes Administered by NSERC:

NSERC does not administer any statutes.

6. Peer Review

Peer review is the assessment of the quality of research proposals or research contributions by impartial experts in the specific field. It is used around the world to assess research contributions, publications submitted to scientific journals, and applications for research funding. It is generally recognized as the best system available to perform these tasks - 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.

In practice there are two aspects to the peer-review system: peer review as used in scientific publishing, and peer review as used by funding agencies. This outline will only discuss the second aspect; it should be noted that there are important differences between the two.

NSERC's peer review process works as follows:

- 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, publications etc.);
  - an itemized budget for the project or program. Only direct costs of the research, such as equipment, supplies, student stipends, and so on, are eligible for NSERC support;
  - other funding previously or currently held by the researcher or the team;
  - for Research Partnerships only, the contribution 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 team for the project.
- The application is sent out for review by international experts in the subject - typically three to five experts are consulted per application. Experts from all sectors, within and outside Canada, may be consulted.
- The application and all reviews received are sent to an expert committee which evaluates each application in the context of all applications received in that field -- this is called (for obvious reasons) the "competition."
- 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), and may include additional criteria, depending on the program to which the applicant is applying.
- The discipline committee recommends whether or not the application should be funded, and (if funded) the size and duration of the grant.
- If the application is unsuccessful, the committee provides feedback to the applicant outlining the reasons for a nil award.

7. Performance Measurement for the Research Grants Program

The Research Grants program is NSERC's largest single budget item, and supports basic university research, as performed by individuals or teams of researchers. It has three broad objectives: support of excellence, maintenance of a diversified research base, and the training of highly qualified personnel.

Establishing appropriate indicators to measure the program's performance is a long-term project which is being carried out under the auspices of Council's Program Evaluation Committee (PEC). This note presents a brief discussion of some aspects of performance measurement using indicators. A more extensive discussion of this issue may be found in the ***Interim Report of the Program Evaluation Committee on Performance Indicators for the Research Grants Program****, which is expected to be available in Spring 1997.*

A performance indicator allows us to measure aspects of a complex issue that cannot be directly measured in its entirety. Such an indicator is always an indirect and to some extent partial measurement of the issue that it aims to address. It is important to bear this indirectness and incompleteness in mind when considering performance indicators, otherwise too much can be read into what a particular performance indicator demonstrates. This problem can be dealt with by:

- developing a variety of indicators to assess different aspects of the issue, and
- using the results of the various measurements in combination - that is, by never relying solely on a single indicator.

Indicators of a program's performance are derived from the program's objectives, that is, what the program was designed to achieve. These objectives are usually given in the program literature. However, the expectations that the program administrators and other stakeholders have of the program must also be taken into consideration when it is evaluated, and when performance indicators are developed. It should also be remembered that different observers and stakeholders may have differing views of a program's objectives.

Performance indicators appropriate for use by NSERC in evaluating its programming have the following characteristics:

- although they will not always be quantitative, they ought to rest on objective data that can command the confidence of the scientific community, central agencies and other readerships. Such performance data would be reported either numerically or as text.
- they are most useful if they can be referenced to a target or an external standard.
- they ought to be selected so as to allow comparisons to be made over time.
- they, and their implications, ought to be easily understood by the various target audiences; and
- collecting them must be cost-effective.

It should also be remembered that:

- Performance indicators are not in themselves judgments or assessments, rather they provide information that can be **used** in assessments; and
- Performance indicators may change as the assessment process is refined.

Attribution

One of the major issues in performance measurement is attribution -- making the linkage between the original research and the observed outcome or impact. This is especially true for longer-term effects.

The path taken by a research result from its publication to its eventual use in the economy or society is difficult to determine. The main reasons for this difficulty are:

- the objectives of the program supporting the research: a program for funding basic research is designed to contribute to the general pool of knowledge. Although some or all of this knowledge may have eventual socio-economic outcomes, it is not easy to trace these outcomes back to the original research program, since such outcomes were not a specific aim of the support program;
- most basic scientific knowledge is freely disclosed, rather than protected as intellectual property. It can therefore be difficult to trace its use and its benefits when it is employed in the private sector;
- the results of scientific investigation are often "enabling," rather than directly applicable to technological innovation, thereby further obscuring any direct trace of their impact.

Finally, the attribution issue is further complicated by the fact that the Research Grants program **assists** in the achievement of its objectives - due to the nature of the program and of the research process, it cannot be held solely responsible for them. In practical terms, Research Grants are grants-in-aid, partially supporting an ongoing program of research; they do not support the full direct costs of a particular project. When examining a grantee's research program, it is not easy to distinguish those elements which are funded exclusively by a Research Grant from those elements which may be partially or wholly supported by other funding sources. For this reason, the Program Evaluation Committee has stated that:

"Because a Research Grant is a grant-in-aid, partially supporting the recipient's broad program of research, to some extent, the entire output of the grantee's research operations is underpinned by the Research Grants program."

This means that NSERC attributes a grantee's entire output at least partially to support received from the Research Grants program, no matter how much of his or her total research support derives from the program.

Selection of Indicators

The Committee looked at two types of indicators, "input" and "output", when determining which indicators to test for usefulness in performance measurement. On the "input" side, test indicators take in all of the three program objectives, as well as the additional impact of funds brought in from other sources.

On the "output" side, two time-scales were considered: shorter and longer term. The "direct" or "short term" effects are a direct result of the researcher receiving the grant. These effects will occur during the term of the grant (e.g., training of graduate students), or while events are still under control of the grantee (e.g., writing up a paper on the research conducted during the term of the grant). Longer-term outcomes and impacts are those occurring some time after the original grant has expired. By that time, other parties (and events) are also likely to have had an influence on the outcome. For example, successful technology transfer involves a series of users and events after the completion of the original research.

Performance measures are now an integral part of program management, and are required by our funders and other interested parties. We are only part of the way through the process of developing these measures for the Research Grants Program, and no conclusions can be drawn on which of the measures identified so far (see Figure 6) should be adopted. There are other substantive issues yet to be addressed, including:

- client satisfaction with the program, which is an important issue for all government programs;
- the cost of delivering the program, including both the "direct" cost to NSERC and the "indirect" hidden costs borne by universities and provided by peers (since the program puts a not inconsiderable administrative burden on university research offices and on peer reviewers);
- the cost of providing performance indicators on a continuing basis; and
- the cost of using whichever measures will be chosen.

8. Advanced Training

8.1 Postgraduate Scholarships Survey

This is the executive summary of the report on recent surveys of former holders of NSERC Postgraduate Scholarships. The full report may be obtained from Mr. Barney Laciak, Senior Budget Analyst, at NSERC.

The Natural Sciences and Engineering Research Council (NSERC) has completed surveys for two years of former Postgraduate Scholarship winners. The objectives of the surveys were:

- to determine the career progression of scholarship winners; and
- to gauge the importance students placed on NSERC funding.

The career status of former scholars and the importance that they attach to NSERC funding to undertake or continue with their studies are indicative that the postgraduate scholarships programs are achieving the aims intended. The feasibility of conducting a survey of former scholarship winners was demonstrated in 1994. Results of the pilot survey and the survey conducted in 1995 are included in this study. Surveys are planned to continue on an annual basis for the foreseeable future.

The two populations surveyed included first-year Postgraduate Scholarship winners in 1985 and 1986, all 1967 Science and Engineering Scholarship winners in 1985, and new 1967 Science and Engineering Scholarship winners in 1986. Over the two years the original population of 1,225 was reduced to a sample of 954 students that were sent surveys. A total of 513 responses were received for a response rate of 53.7%. The major findings of the first two surveys can be summarized as follows:

- The unemployment rate for respondents is very low, estimated to be between 2.1% and 2.7%.
- A high percentage (65.5%) of respondents are active in a research and development capacity, using their training for one of the primary purposes of the scholarship programs.
- 73.1% of respondents feel that their graduate training was "critical" to their careers.
- 98 respondents (19% of the total) were living outside the country at the time of the survey. More than half of these respondents intend to return to Canada.
- 96.1% of the respondents completed the degree (master's or doctorate) for which they received NSERC funding.
- 89% of the respondents said that NSERC funding was at least moderately important to undertake or continue with their studies.
- The respondents' average completion times (1986 respondents) for bachelor's, master's and doctoral degrees were 3.72, 2.32 and 4.36 years, respectively. The average completion

times for master's and doctoral degrees reported in this survey are similar to times reported by the Canadian Association of Graduate Schools for a much larger population.

- 73% of the 1967 Science and Engineering scholarship winners went on to complete their doctorate, an important objective of the program.
- Just under half (43%) of the respondents wrote remarks in the Comments section of the questionnaire. Most of the remarks were "positive" -- expressing gratitude for having had the scholarship, and otherwise complimentary towards NSERC.

8.2 Next Generation Workshop

This is the text of the editorial from a recent issue of NSERC's newsletter, Contact, which dealt with the Workshop and the issues surrounding it.

Canadians are becoming very conscious of demographics. A popular book on demographics has become a Canadian best seller. Politicians debate the impact of an ageing population on the future of the Canada Pension Plan. And Canadian students are finding that many senior professors have retired, or taken early retirement, and disappeared from university lecture halls.

Demographics also has inevitable and profound implications for science and technology in Canada. It is becoming evident that the country's capabilities in science and technology at the dawn of the new millennium will depend very much on today's graduate students, postdoctoral fellows and junior faculty. The extent to which they succeed will determine the health of the entire enterprise. Helping them launch their research careers and keeping them in Canada poses a major challenge for NSERC. The challenge is all the greater because it must be met within constrained resources and at a time of great uncertainty and change in the universities and in industry. Nevertheless, this is the most *strategic* of all investments that NSERC can make in Canada's capabilities in science and technology, and that means that Council must be strongly focused on meeting the needs of the new generation of Canadian researchers.

To discuss how best to do this, NSERC held a working meeting in Ottawa over the first weekend of October. The 30 invited participants included graduate students, postdoctoral fellows, junior faculty, two young researchers from industry, Council members and members of NSERC's grant selection (GSC) and policy committees. Members of NSERC senior staff and the President also took part.

Working in focus groups, with professional facilitators, the participants developed recommendations to NSERC, to the universities, to government, and to the young researchers themselves as a group. They ranked the recommendations according to impact: high, medium, or low, and according to ease of implementation: easy, hard, and very hard. The time required to effect the change represented a third dimension.

Some of the easy things for NSERC to do that might have a high impact were:

- sensitize GSCs to take into account issues facing junior faculty members who are trying to establish themselves;

- ensure GSCs consider other (e.g. non-academic) experience of the applicants and the training of students for industrial careers as relevant in evaluating grant applications;
- remind GSC members that they are ambassadors for NSERC and suggest that they can be proactive in educating new researchers about the granting process at their own universities;
- make it an explicit purpose of site visits to help junior faculty.

At the other extreme, a very difficult challenge arises in providing new faculty with the resources to get started in their research, at a time when NSERC and many universities are having to cope with budget cuts. This situation is exacerbated by the high teaching load that junior faculty must carry at the same time they compete for research grants with their senior colleagues, some of whom have taken early retirement and are now able to spend most of their time on research. Many measures will have to be explored in addressing this issue, both at NSERC and at the universities, and none of them will be easy or quick.

It also became clear during the workshop that an academic career is no longer the dominant option for many young Ph.D.s. However, in many ways the postgraduate education system still treats it as the only career for which graduate students are being prepared. This raised many questions about university-industry relations, for example, industry attitudes to postgraduates.

Participants felt that industry must abandon the view that Ph.D.s are qualified only to pursue research emerging from their theses and, correspondingly, Ph.D. students and their supervisors should have broader expectations. Industrial recruiters need to look at Ph.D.s as extraordinarily skilled problem solvers, who know the value of knowledge and where to find it, who understand its limitations and are aware of its trends, and who have demonstrated the ability to generate it as needed -- and universities should also begin to see Ph.D. studies in that light. This raises questions about the difference between advanced education *in* research and advanced education *for* research.

Another question raised was the duration of Ph.D. studies. For example, in areas of fast-moving technology, industry is expressing a growing preference for people with a Master's degree, who become available for employment much more quickly. Such questions need to be explored in depth by the universities, by industry, and by NSERC.

One theme that appeared throughout the Workshop discussions was the need to raise awareness among the general public about the value and importance of research in the natural sciences and engineering. The general recommendation was addressed to everyone: NSERC, universities, government and young researchers, but no really new ideas emerged. The suggested measures were all things that are already being tried. Clearly, this is still an unmet challenge for the entire Canadian NSE research community.

Will this Workshop make a difference? NSERC will do all that it can. We have started already. Charles Levert, a doctoral student, and Cheryl Wellington, a postdoctoral fellow, have already been appointed to the Committee on Research Grants. Jean St. Pierre, a senior engineering scientist with Ballard Power Systems (and a former NSERC Industrial Research Fellow), and David Woodfine, a doctoral student at Trent University, have been appointed to the Committee

on Scholarships and Fellowships. All have attended their first meeting as committee members and brought important new perspectives to the discussions.

NSERC staff are looking at the feasibility of implementing the recommendations that were addressed to us. We are also figuring out what to do with the recommendations made to others -- universities, government, and the young researchers themselves -- so that they might lead to constructive action.

Finally, there is a need for at least one more workshop. Many questions were raised about the involvement of young Canadian researchers in industry, and they have to be explored with a group of people who are personally familiar with that sector.