Report of the
International Review Committee
on the Discovery Grants Program

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Abbreviations

ARIF	Average Relative Impact Factor
CIHR	Canadian Institutes for Health Research
DGP	Discovery Grants Program
GSC	Grant Selection Committee
HERD	Higher Education Sector Expenditure on R&D
HQP	Highly-qualified personnel
NSE	Natural sciences and engineering
NSERC	Natural Sciences and Engineering Research Council
NIH	National Institutes of Health (US)
NSF	National Science Foundation (US)
OST	Observatoire des sciences et des technologies
PDF	Postdoctoral fellow
SSHRC	Social Sciences and Humanities Research Council

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Report of the International Review of the Discovery Grants Program

Executive Summary

The Discovery Grants Program ("DGP") is the largest individual program of the Natural Sciences and Engineering Research Council (NSERC). The DGP provides a broad base of support for university research in the natural sciences and engineering ("NSE") and is also a key resource for training at the undergraduate, graduate and postdoctoral levels.

Concerns have been raised as to whether (a) the relatively high success rate in DGP competitions (currently, 70% of DGP applicants receive some funding); and (b) the modest size of the average grant (about $32,000), are incompatible with an objective of supporting the best researchers at a world-class standard. To address this and related issues, NSERC established an International Review Committee. This report summarizes the findings and recommendations of the Committee and constitutes one part of NSERC's review of the Discovery Grants Program.

Characteristics of the Discovery Grants Program

Several features distinguish the DGP from most other research funding programs in Canada and abroad.

a) *The DGP funds "programs" not "projects".* The research supported by Discovery Grants represents the ongoing research interests of applicants, and the DGP permits the flexibility to adjust the goals and conduct of their "research programs" in response to results and unanticipated opportunities, encouraging creative and cutting-edge approaches, and interdisciplinary collaborations. By contrast, the great majority of university research funding in Canada and abroad is tied to specific projects with tightly-defined objectives and deliverables.

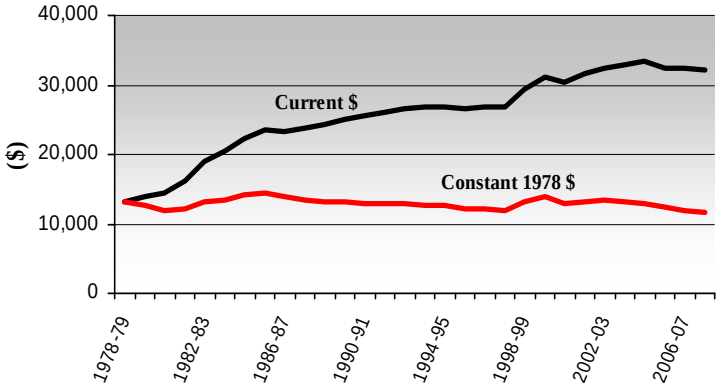
b) *Base Funding.* Discovery Grants are designed to provide a stable base of research support, a key component of which is the training of students across the range of the NSE domains. The DGP permits the long-term planning of a research program provided the productivity and quality of the research is maintained. Grant holders have the opportunity to build on the DGP base with further support from multiple sources though never from more than one Discovery Grant at a time.

c) *Duration of Funding.* More than 80% of Discovery Grants have a 5-year term – much longer than is typical for project-based funding. A secure 5-year duration is particularly suited for the support of graduate students.

d) *Support of Direct Costs.* Discovery Grants may only be used to fund the direct costs of research. The DGP thus differs importantly from many other research support systems that allow grants to also be used for faculty salaries and/or general overheads. The size of a Discovery Grant, therefore, will typically be much less than that of an otherwise comparable award that includes investigator salaries and indirect costs.

In 2007-08, the DGP will award grants totalling $328M to some 10,300 researchers. The average DGP award per investigator has declined in recent years in constant dollar terms (Fig. A). This decline reflects the substantial recent growth in the number of faculty members supported by the DGP due primarily to (a) massive university hiring in the face of retirements; (b) increasing enrolment in Canadian universities; and (c) growing R&D funding to support the research and advanced skills training needed in an increasingly knowledge-intensive economy.

Figure A - Trend in the Size of the Average Discovery Grant



Source: NSERC

Almost 60% of DGP funds go to support the training of students, postdoctoral fellows and research support personnel (e.g. technicians). Some 30,000 individuals, almost 90% of whom are students, receive some stipend support from Discovery Grants. (A further 38,000 people are also involved in research undertaken by grantees but not supported by DGP funds).

Findings of the Committee

The charge to the Committee consisted of three groups of questions, the first of which is:

To what extent is NSERC successful in supporting the best researchers at a world-class level through its overall suite of programs? To what extent is the research supported through the Discovery Grants program having an impact on the international scene?

The Committee believes that the Discovery Grants Program, in concert with other NSERC and non-NSERC funding, has generally supported Canada's best researchers at an internationally competitive level.

DGP support is far from uniform across the range of grantees and the data suggest that more meritorious research is more heavily supported. For example, the top 10% of the size distribution of Discovery Grants comprised nearly 21% of total funds awarded in 2005-06. The bottom 30% of the grant-size distribution accounted for only 17.4% of total DGP funds. Award holders typically obtain 40% to 60% further funding from other NSERC programs to supplement their Discovery Grants – and the larger the grant, the larger tends to be the "leverage ratio". Thus excellence is amplified.

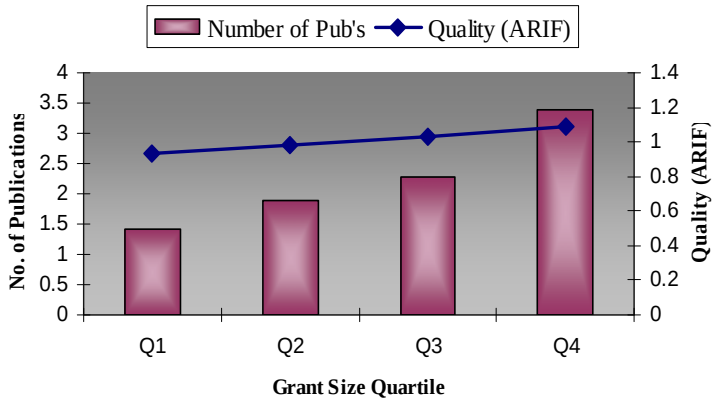
Discovery Grants are often supplemented substantially by non-NSERC sources (though the ability to attract such funds varies substantially across disciplines). The evidence shows that the best, and most expensive, Canadian research receives substantial support beyond the DGP. For example, the top one percent of DGP grant holders have total funding from *all* sources that averages almost $350,000 annually, or roughly 3.5 times the total funding of the average DGP grantee.

The Committee believes that Canadian research in most NSE disciplines is of high quality as gauged by citation intensity, which is arguably the best gross indicator of impact.

Since the DGP is NSERC's primary source of support for discovery research, it is reasonable to infer that this program is the key driver of Canadian academic research publications in the NSE disciplines. Research impact depends on both the volume and quality of publications. Canadian NSE publications in 2005 represented 4.5% of the global total placing Canada 7th worldwide in absolute number and 1st among G-7 countries in NSE publications *per capita*. The most widely accepted overall measure of publication quality is the Average Relative Impact Factor (ARIF) – a numerical indicator related to the (global) rate of citations to literature in a given field produced by researchers in a particular country. By this measure, Canada ranked 9th worldwide in 2005, and 4th among G-7 countries in the NSE disciplines overall. The ARIF data also show that Canada's system produces a relatively even quality of research across the seven major NSE sub-fields with Canada ranking from 6th to 16th among the 32 countries rated.

Data on the volume and quality of research publications by Discovery Grant holders show that there is relatively little variation in average publication quality (proxied by ARIF) as a function of grant-size (Fig. B). These data demonstrate that even small Discovery Grants can support high quality research across the broad base of grantees, while the larger grants result, on average, in a higher rate of production.

Figure B – Publication Volume and Quality by Grant-Size Quartile (Average across all GSCs)



Source: NSERC estimates, OST.

The second element of the charge to the Committee asks:

What should be an appropriate balance between the following two objectives of the Discovery Grants program: "promoting and maintaining a diversified base of high

quality research capability in the natural sciences and engineering in Canadian universities" and "fostering research excellence"?

The Committee believes that the Discovery Grants Program generally strikes an appropriate balance between these two objectives though there are opportunities for improvement (outlined subsequently).

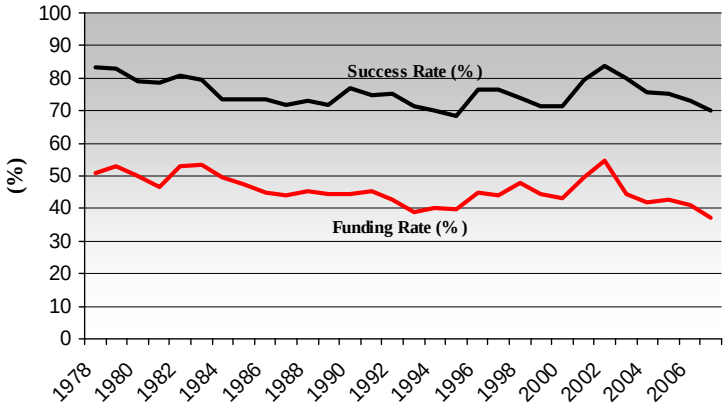
The evidence reviewed by the Committee demonstrates that the perception that the DGP is flawed because of a "high success rate" is an inaccurate reading of the actual situation. The success rate of the DGP – 70% in 2007, down from over 80% in 2002 (Fig. C) – cannot readily be compared with the typically quoted success rates of most other research support programs. This is because the objectives and modalities of various programs differ substantially. For example:

a) The DGP is designed to provide a base of support to a broad spectrum of active NSE researchers and their trainees. In other disciplines, and in other countries, this broad research enablement is typically provided by a patchwork of mechanisms – e.g. funds provided through the university; from state/provincial agencies; from the private sector – rather than by the "headline" grant programs which are usually project-based and typically have relatively low success rates for individual applications. The latter grants are often heavily "taxed" by the host institution to defray the indirect costs of research. A portion of the funds may, at the discretion of the university, be returned to the researcher for flexible use. This would provide support analogous to a Discovery Grant but in a less transparent and more round-about way.

b) Only one DGP award may be held at one time, whereas other programs usually allow an investigator to hold multiple grants simultaneously. This increases the effective success rate "per individual" as opposed to "per application".

It is emphasized that applicants to the DGP typically receive less than the amount requested. The grant size, as a proportion of the request, ranges from about 37% for the lowest grant-size decile to 70% for the highest decile. The funding ultimately awarded in 2007 was only 38% of the total requested by all applicants, including both the successful and unsuccessful (Fig C). This provides an important further perspective on the DGP "success rate".

Figure C - Trend in DGP Funding Rate and Success Rate (Competition Years)



Source: NSERC

The third element of the charge to the Committee asks:

To what extent is the philosophy of the Discovery Grants program suited to the Canadian context and Canada's needs for research results and highly qualified personnel?

The Committee believes that the Discovery Grants Program is an exceptionally effective model for supporting Canadian research in the NSE fields principally for the following reasons.

a) The philosophy and design of the DGP make it suitable not only for Canada's circumstances but also for those of university research environments in many other countries.

b) In Canada's particular case, where competition with US universities for top talent is omnipresent (and increasingly as well from other research institutions worldwide). The DGP provides several unique attractions for individual researchers – e.g., flexibility as to research directions; a low burden of proposal submission due to the DGP's reasonably high success rate and (typical) five-year tenure; and an environment for reliable medium-term support of graduate students. This makes Canada more attractive in the global competition for top research talent.

c) The DGP's relatively high success rate effectively supports good researchers and their students across many fields and in all parts of the country, as well as those individuals that need only modest funding to be successful.

Any significant intentional reduction in the DGP success rate – in order to further concentrate funds on fewer researchers – would inevitably have a disproportionate impact on those currently receiving smaller grants. This would result in reduced research support in the smaller provinces and in small institutions.

Recommendations

The Committee believes that the DGP has been remarkably successful in achieving its objectives and that those objectives are appropriate for Canada. The Committee nevertheless believes that the DGP can be improved and therefore recommends as follows.

1. An applicant's previous Discovery Grant should not be the starting point for a new grant. There is evidence that Grant Selection Committees (GSCs) may sometimes rely too much on the amount of an applicant's previous grant and are conservative in making changes to an award from one funding cycle to the next. To ensure that grants are entirely merit-based, and thus to increase the funds available for strong proposals, the Committee recommends that:

- Each GSC should first rate the proposals under consideration according to merit criteria and *without reference* to the proposer's prior grant amounts, requested budget, or a "need for funds" criterion.
- The merit rating would assign proposals to a number of "bins" – e.g., "Must fund", "Fund if resources are available", "Possibly fund", and "Do not fund" – perhaps using some measure of forced distribution to prevent rating inflation.
- Only after all proposals have been merit-rated in bins, should the GSCs consider the allocation of funding (based on the requirements set out in the proposal budget).
- A separate merit-rating process and funds allocation should continue to be set aside to support *early-career* researchers. The current NSERC target guideline of 50% success for this group is reasonable, subject to assurance of high quality.

- NSERC should review its current selection criteria to include elements such as the potential for the research to be "transformative" and to better define the intent of the "need for funds" criterion.

2. Increase the number of Discovery Accelerator Supplements[*]. The Accelerators are a particularly effective way to encourage excellence by helping researchers with unusually promising and timely ideas to "seize the moment". The Committee recommends doubling the annual limit on new Accelerators supplements to 200. This increase should not be at the expense of existing programs but rather continue to be from new funds received by NSERC.

3. Revise the Grant Selection Committee structure. The Committee would endorse proposals to:

- Cut the number of GSCs from the current 28 roughly in half (with the details to be advised by the 'Sedra' committee). This would facilitate assessment of transdisciplinary proposals and, by virtue of substantial structural rearrangement, reduce any "inertial" tendencies implicit in the long-standing existing GSC set-up;
- Increase the number of GSC members who are based outside Canada. Roughly doubling the current proportion to about 15% would be an appropriate target. NSERC should streamline GSC procedures to make membership more attractive for non-Canadians;
- Ensure that every DGP proposal has at least one reviewer from abroad providing a written report.

4. Increase support for training of highly-qualified personnel. This is especially needed for postdoctoral fellows (PDFs) coming from abroad, who are not currently eligible for *direct* NSERC program support. (DGP grant holders can, at their discretion, use their funds to support foreign-based graduate students and PDFs). The Committee recommends that:

- Canada strengthen its ability to attract international PDFs and specifically endorses NSERC's proposed new CREATE program;
- New mechanisms be developed to encourage Canadian PDFs who study abroad to return to Canada. This could perhaps be modeled after the NSF CAREER awards or the "Future Fellowship" of the Australian Research Council.

5. At a minimum, the DGP should be funded at a level sufficient to keep the average grant-size from decreasing in real (constant dollar) terms.

The Committee considered proposals that have been put forward from time to time to place upper and/or lower bounds on the size of Discovery Grants. It concluded that **there should *not* be a uniform NSERC-mandated lower limit on the size of a Discovery Grant**. It may nevertheless be appropriate to establish minimum grant-sizes based on discipline-specific factors and thus varying across Grant Selection Committees. The Committee also concluded that **there should *not* be an upper limit – either absolute or varying by discipline – on the size of grants.** This would limit a GSC's discretion to support outstanding proposals.

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[*] NSERC has recently established this new category of award, within the DGP, to support a select group of grantees whose research shows exceptional promise of rapid and significant progress. Currently, NSERC makes available each year 100 three-year "Accelerator" awards ($40,000 per year).

In Summary

Based on the evidence before it, the Committee has concluded that: (a) the relatively high success rate of DGP applications is *not* incompatible with, and in fact encourages, a high degree of research excellence across a broad range of fields; (b) the best researchers are able to use support of a Discovery Grant as a base to lever an internationally competitive level of funding from other sources; (c) the broad base of DGP grants sustains an important level of research capability and student training across the NSE disciplines and throughout Canada and thus contributes significantly to meeting the nation's needs for research results and highly-qualified people; and (d) the DGP is therefore an exceptionally productive investment and thus deserves additional funding to ensure that the value of its grants keeps pace with the growing opportunity.

1. Introduction

The Government of Canada recently carried out a "Value for Money and Governance" review of the three federal research granting agencies – the Natural Sciences and Engineering Research Council (NSERC), the Canadian Institutes for Health Research (CIHR) and the Social Sciences and Humanities Research Council (SSHRC)[1]. The review recommended, among other things, that:

> *NSERC (and SSHRC) should take steps to demonstrate to themselves, to their research communities and to the government that their research funding programs are truly aimed at supporting excellence in research.*
>
> *NSERC should commission an international review team and consult the relevant Canadian stakeholders to determine whether its current awards/applicants funding ratio of 75% in discovery research is consistent with international standards of excellence and whether this funding approach is appropriate. The results of this review should be communicated to the government and made public.*

The concern in respect of NSERC related primarily to its Discovery Grants Program ("DGP"), which has a relatively high success rate compared with programs of other research granting bodies in Canada and abroad – currently about 70% of DGP applications are funded. To address this and related issues, NSERC established an International Review Committee (the "Committee") to consider whether the DGP, together with the other NSERC programs, were able to support the best researchers at a level sufficient to perform at a world-class standard. This report summarizes the findings of the Committee and constitutes one part of NSERC's review of the Discovery Grants Program.

1.1 Charge to the Committee

The charge to the Committee was as follows[2]:

> *To what extent is NSERC successful in supporting the best researchers at a world-class level through its overall suite of programs? To what extent is the research supported through the Discovery Grants Program having an impact on the international scene?*
>
> *What should be an appropriate balance between the following two objectives of the Discovery Grants Program: "promoting and maintaining a diversified base of high quality research capability in the natural sciences and engineering in Canadian universities" and "fostering research excellence"?*

[1] Unpublished – December, 2006

[2] The Committee slightly simplified and re-ordered the questions put to it while preserving the original intent.

To what extent is the philosophy of the Discovery Grants Program suited to the Canadian context and Canada's needs for research results and highly qualified personnel?

To these questions, the Committee itself added a further charge:

How should the Discovery Grants Program be improved?

1.2 Methodologies

The Committee had access to a number of documents prepared by NSERC or by consultants on behalf of NSERC, including:

- a statistical portrait of Canadian R&D;
- an overview of NSERC and the DGP;
- a bibliometric review of Canadian publications in the natural sciences and engineering;
- invited written submissions on the DGP from key stakeholders comprising university V-Ps research, councils of deans, committees of department chairs, and scientific societies;
- results from an NSERC survey of roughly 4,200 representative Discovery Grant holders and 260 non-funded applicants;
- feedback from a number of interview programs involving DGP awardees; 42 international and/or non-academic members of DGP Grant Selection Committees; and representatives of the private sector and government;
- comparisons with ten other Canadian and international academic granting programs (see Appendix 2); and
- in-person presentations to the Committee by two DGP grant holders, a Dean of Graduate Studies and Research, a Dean of Engineering, and a Vice-President Research.

The Committee considered this information over a period of two days in each of two meetings (Toronto on October 27 – 28, 2007, and Montréal on February 21 – 22, 2008), and in a teleconference on March 7, 2008. This report presents the principal conclusions of those deliberations and summarizes the key evidence on which the Committee's finding were based[3].

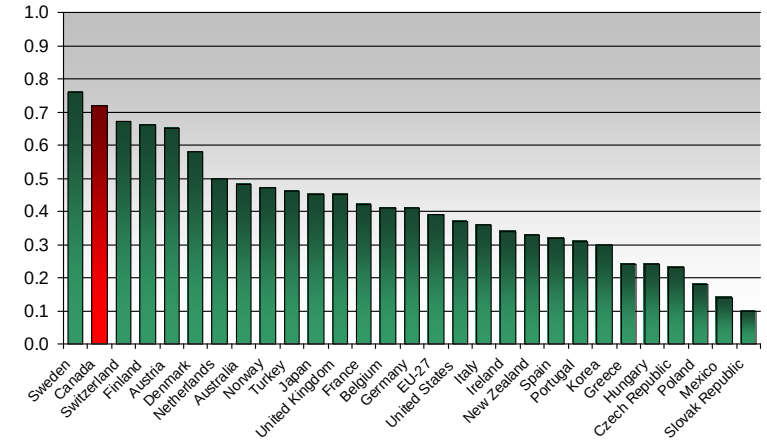
[3] All committee members participated in all discussions with the following exceptions – Sir Graeme Davies was unable to participate in the Montreal meeting and the March 7 teleconference; Ernst-Ludwig Winnaker participated in only part of the Montreal meeting and by teleconference and was unable to participate in the March 7 teleconference; Kathie Olsen was unable to participate in the Toronto meeting and participated in the Montreal meeting by teleconference.

The report is organized as follows. Section 2 presents the context in which the Discovery Grant Program is set. Sections 3 through 5 address each of the elements in the original charge to the Committee. The Committee's recommendations concerning ways in which the Discovery Grants Program might be improved are presented in Section 6. A short concluding statement is found in Section 7.

2. Setting the Context

Canada's Higher Education Expenditure on Research and Development (HERD) – currently more than 0.7% of GDP – is second only to Sweden among OECD countries (Fig. 1). The higher education sector performs almost 40% of all R&D in Canada, by far the largest share among G-7 countries. Canada's HERD has increased substantially over the past decade – from 0.46% of GDP in 1996 to 0.72% in 2005. The importance of this sustaining leadership has been recognized in the federal government's science and technology strategy document (2007) – *Mobilizing Science and Technology to Canada's Advantage* – which explicitly establishes the goal of "Maintaining our G-7 leadership in public R&D performance."[4]

Figure 1 - HERD as a Percentage of GDP, 2005 or Latest Year

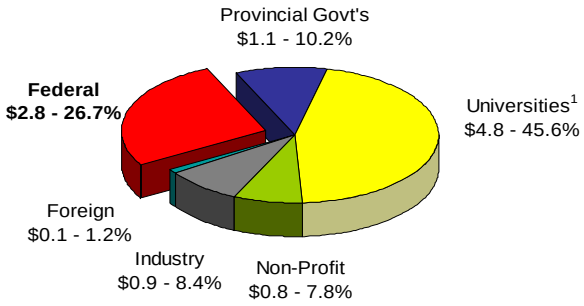


Sources: OECD, Main Science and Technology Indicators

Canada's universities themselves funded approximately 45% of the $10.4 billion of R&D performed by the higher education sector in 2007, with the majority of that contribution allocated to the salaries of researchers and indirect costs of research (Fig. 2). Federal government support totalled $2.8 billion.

[4] http://www.ic.gc.ca/epic/site/ic1.nsf/en/h_00231e.html

Figure 2 - University R&D Funding in Canada, 2007
(billions of dollars)



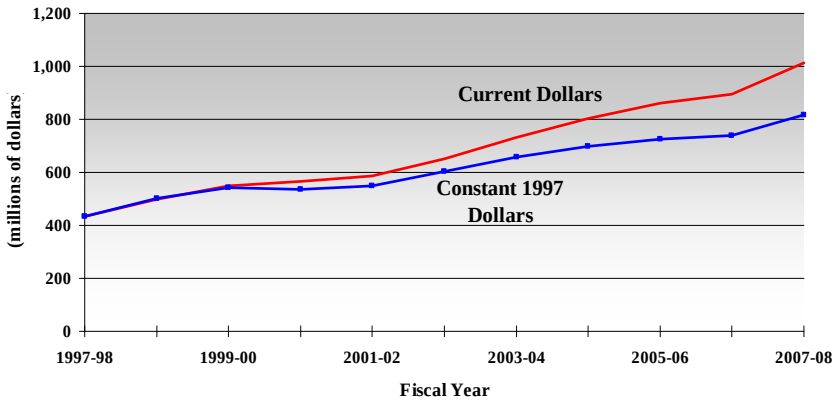
Total: $10.4 Billion

1. Includes faculty salaries and indirect costs related to research.

Source: Statistics Canada

University research in the natural sciences and engineering (NSE) currently receives federal support of about one billion dollars annually via the Natural Sciences & Engineering Research Council (Fig. 3).

Figure 3 - NSERC Expenditures



Source: NSERC

The mission of NSERC is to:

> *… make Canada a country of discoverers and innovators for the benefit of all Canadians. To achieve this, we invest in people, discovery and innovation in Canadian universities and colleges* [5].

[5] http://www.nserc.gc.ca/about/about_e.asp.

NSERC has many programs that support each of these three theme areas – people, discovery and innovation – but the largest proportion of its total budget is used to support "discovery research". The full suite of NSERC programs is summarized in the following table. A detailed list is provided in Appendix 1.

Table 1 - Summary of NSERC Areas of Support [6]

Program Category	Purpose	Budget ($M) 2007-08	% of Total
People	Support students as they prepare to become Canada's next generation of experts.	135.6	14.9
	Create and support faculty positions. These ensure the availability of experts in a wide variety of fields to train the next generations, perform research, and act as expert resources for other parts of the innovation system.	162.3	17.8
	Celebrating excellence, research achievements and research partnerships with industry, and promoting a science culture in the Canadian public.	6.6	0.7
Discovery	***Discovery Grants Program (Approximately 60% of DGP funds go to support "people", thus the "People, Discovery and Innovation" categories actually overlap.)***	328.2	***36.0***
	Support the conduct of research and ensure Canada's on-going involvement in the generation of knowledge, new ideas, and the capacity to build on the advances of knowledge made elsewhere.	61.0	6.7
Innovation	Accelerate research in areas of strategic importance to Canada.	89.9	9.9
	Support the productive use of knowledge through partnership projects where university researchers help to solve problems or find answers to issues raised by companies.	78.1	8.6
	Provide resources and experts to accelerate the process of transferring knowledge and technology to the user sector.	49.4	5.4
General support		0.9	0.1
	Total	912.1	**100.0**

Source: NSERC

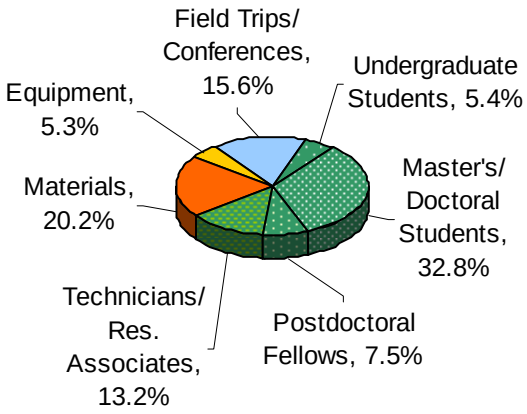
[6] Excluding the administration budget of $44.7M

2.1 The Discovery Grants Program

The Discovery Grants Program is NSERC's largest individual program and provides an underlying base of support for "discovery" research in the natural sciences and engineering. The program is also a key source of support for training in research at the undergraduate, graduate and postdoctoral levels (Fig. 4). The DGP has been the centerpiece of NSERC's suite of programs since the Council's creation in 1978, during which time it has operated under a succession of names – Operating Grants; Research Grants, and now Discovery Grants. Though the DGP has evolved over time, its basic philosophy has remained essentially unchanged. The objectives are to:

- *Promote and maintain a diversified base of high-quality research capability in the natural sciences and engineering in Canadian universities;*
- *Foster research excellence; and*
- *Provide a stimulating environment for research training*[7].

Figure 4 – Discovery Grants Expenditures by Categories, 2006-07



Total: $328 Million

Source: NSERC

The following significant features distinguish the DGP from most other research funding programs in Canada and abroad.

[7] http://www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=a1

- **Funding Programs vs. Projects.** Discovery Grant applications are made for long-term "programs" of research[8]. These *individual* programs represent the ongoing research interests of the applicants, and the DGP allows them the flexibility to adjust the goals and conduct of their research in response to results and unanticipated opportunities. This distinguishes the DGP from virtually all other research support methods in Canada and abroad. Those typically provide funding support for specific "projects". Research project funding tends to be shorter-term with explicitly defined deliverables and timeframes and, consequently, permits little flexibility for the grantee. Discovery Grants are widely thought to be more likely to foster "out-of-the-box" approaches and thus greater creativity.
- **Duration of funding.** Discovery Grants are awarded for one to five years, with more than 80% having a 5-year term. A secure duration of this length is particularly suited for the support of graduate students, especially at the doctoral level.
- **One Discovery Grant at a time**. Researchers can hold only one Discovery Grant at a time. More than 95% of the grants are held by individual researchers[9]. This also distinguishes the DGP from many other Canadian and international programs that allow principal investigators to hold multiple grants simultaneously *from the same overall program,* – e.g., CIHR's Operating Grants or NSERC's programs that support projects, such as the Strategic Project Grants program.
- **Support of Direct Costs**. Discovery Grants may only be used to fund direct research costs – e.g., student and technician salaries and stipends, materials and supplies, consumables, travel. The DGP cannot be used to support the salary of the faculty member, or any overhead or indirect costs of the institution. (The latter are covered by the universities themselves with the assistance of federal transfers to individual institutions under the Indirect Costs Program). The DGP differs significantly from many other research support systems that allow grants to be used also for faculty salaries and/or general overhead. For example, US research grants are commonly used to pay some part of the salaries of the faculty members, and US institutions commonly require that a part (typically 30 - 40%[10]) of an external research grant be used to pay for the institution's indirect research costs. In practice, this means that the direct support for the conduct of research provided by one of these grants would be much less than the face amount awarded.

Discovery Grants have several unique advantages from the perspective of the research community. These were well expressed in a letter from a grant holder that was typical of many testimonials reviewed by the Committee, the great majority of which were strongly supportive of the DGP (see box).

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[8] Here "program" refers to the elements of a long-term plan of research for the individual investigator holding the grant. The term should not be confused with "program" in the bureaucratic sense of a system used by governments to provide research grants.

[9] Researchers who apply individually can use their grants to participate in collaborative efforts.

[10] A US indirect cost rate of 50%, for example, would mean that one-third (33.3%) of the grant would go to indirect costs.

Advantages of the DGP from a Researcher's Perspective

Excerpt from a letter from a Discovery Grants holder

. . . one of [the] major strengths [of the Discovery Grants Program] is that it requires that the research be proposed and conducted within a "program framework". The applicant is requested to present his or her research proposal in terms of a cohesive set of projects . . . . As in any research proposal, the applicant must present short-term research goals: the specific objectives, likely outcomes and significance of each project within the 5-year duration of the Discovery Grant award. However, the applicant must also present long term (>5 years) research goals that the current set of projects will advance towards. This contrasts with a "project framework", which is the more usual research structure found in other research funding . . . In the project framework, all goals are short-term and must be achieved within the timeframe of the award . . .

[The] unique [program framework] feature of the NSERC Discovery Grant Program has a number of very interesting outcomes.

- Crafting a proposal within the program framework helps the applicant during the earliest stages of their first academic appointment to map out how they would like their research career to develop . . . Many new as well as established researchers have commented on the value of developing this long term plan, with each successful award seen as a contributing step towards major long term goals.
- . . . the program framework encourages the applicants to ask: what are the big questions in my field? It then allows the ambitious targeting of such questions, . . . , while also requiring demonstrable progress and meritorious achievements within the 5-year timeframe.
- The program framework leads to a more cohesive set of research objectives in each laboratory. . . and [contributes to] the international recognition of each laboratory as a center of excellence in a specific research area.
- This approach also allows research trainees to place their work within a bigger picture, and to better understand the broader scope and context of their specific project.
- Finally, the Discovery Grant Program recognizes the dynamic nature of research: the stated long term research goals are expected to evolve and sharpen as a function of new results, breakthroughs, technologies and ideas, allowing a considerable flexibility in pursuing the most promising lines of inquiry unmatched in project-based programs, and resulting in maximum impact.

Applications for Discovery Grants are reviewed by Grant Selection Committees (GSCs), currently 28 in number, representing the entire range of NSE disciplines. The members of GSCs, who are appointed for three-year terms, are selected for their expertise and experience both as researchers and as research users. The GSCs receive input from external referees based in Canada and abroad who each provide a written evaluation on a subset of the applications reviewed by a GSC. Applications are currently judged according to the following criteria set out in Table 2.

Table 2 – Existing Selection Criteria for the Discovery Grants Program

Criteria	Basis for Evaluation
Scientific or Engineering Excellence of the Researcher(s)	Knowledge, expertise and experience;
	Quality of past or potential contributions to, and impact on, the proposed and other areas of research;
	Importance of contributions to, and use by, other researchers and end-users;
	Complementarity of expertise of the members of the group and synergy (where applicable).
Merit of the Proposal	Originality and innovation;
	Significance and expected contributions to research;
	Clarity and scope of objectives;
	Clarity and appropriateness of methodology;
	Feasibility;
	Extent to which the scope of the proposal addresses all relevant issues, including the need for varied expertise within or across disciplines.
Contribution to the Training of Highly Qualified Personnel	Quality and extent of past and potential contributions to the training of highly qualified personnel;
	Appropriateness of the proposal for the training of highly qualified personnel;
	Enhancement of training arising from a collaborative or interdisciplinary environment (where applicable).
Need for Funds	Appropriateness of, and justification for, the budget;
	Availability of other sources of funding and their relationship to the proposal;
	Special needs related to the nature of collaborative activities or infrastructure costs such as user fees.

The DGP does not operate in isolation within Canada's academic research environment for the natural sciences and engineering. Discovery Grants are intended to provide the underlying *base* of support for NSE researchers, who also are eligible to participate in all other NSERC research grants programs. As well many NSE researchers have access to a wide range of grants from non-NSERC programs. For example, an investigator studying genetics and genomics with the support of a Discovery Grant may concurrently hold various kinds of research support from a broad range of sources that may include, for example:

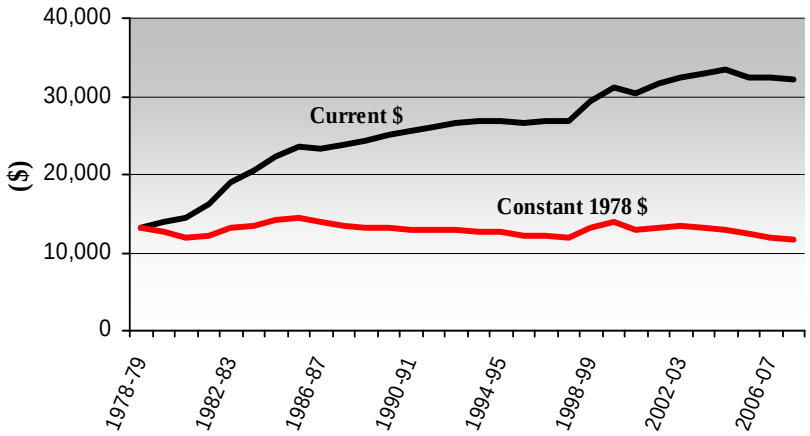
- Other NSERC programs;
- CIHR (if there are health implications of the research);
- SSHRC (if there are societal implications);
- The Canada Research Chairs program (providing salary support to the researcher's university, which may in turn provide teaching relief that allows the Chair to dedicate more time to research);

- The Canada Foundation for Innovation (that provides funding to universities to purchase or build equipment, labs, and institutes);
- Genome Canada (which supports five major genomics research centres across Canada);
- A networked research team such as one of those in the Networks of Centres of Excellence and/or the Canadian Institute for Advanced Research;
- Federal government departments and agencies that conduct or contract out research with academic investigators;
- Provincial programs (e.g., Ontario Centres of Excellence, Alberta Heritage Foundation for Medical Research, Fonds Québécois de la recherche sur la nature et les technologies);
- Contract research funding from industry;
- International granting programs that allow support for non-nationals (e.g., some programs of the US National Science Foundation or National Institutes of Health);
- The researcher's own university.

Of course, not every researcher would be eligible for all of these funding sources, nor would the researcher necessarily succeed in the relevant competition. It is nevertheless common for investigators to have support simultaneously from multiple sources (though never from more than one Discovery Grant at a time). A notable further benefit of a Discovery Grant is that it allows for the development of depth in expertise in one area, which can then contribute to collaborative, transdisciplinary research undertakings.

Funding the Discovery Grants Program: The DGP budget, in current dollars, has increased by a factor of about six over the nearly 30 years since its inception. In constant dollar terms, funding for the program has grown by 70% over this period. In 2007-08, the DGP will award grants totalling $328M to some 10,300 researchers. The average DGP award per investigator has declined in recent years in constant (1978) dollar terms – for example, by 13% between 2002-03 and 2007-08 (Fig. 5).

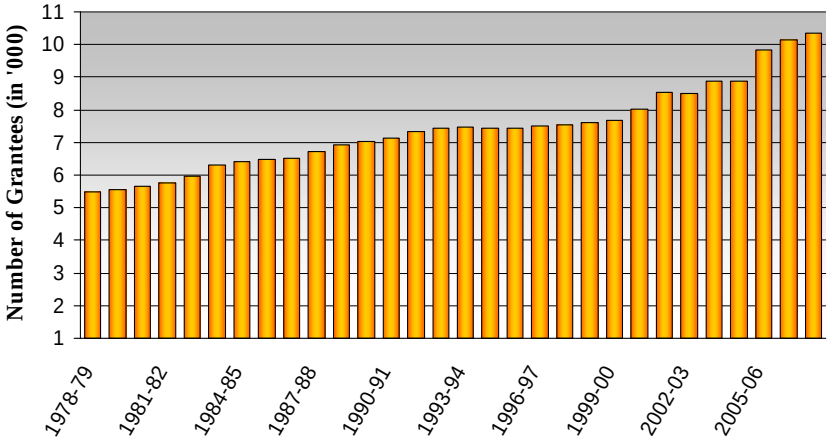
Figure 5 - Trend in the Size of the Average Discovery Grant



Source: NSERC

This decline reflects the substantial growth in the number of faculty members supported by the DGP since the late 1990s – i.e., an increase of 36% from about 7,600 grantees in 1998-99 to 10,300 in 2007-08 (Fig.6). The strong growth has been due primarily to a combination of (a) strong university hiring in the face of retirements; (b) increasing enrolment in Canadian universities; and (c) growing R&D funding to support the research and advanced skills training needed in an increasingly knowledge-intensive economy. Newly-hired faculty have the qualifications and desire to be actively engaged in research and this is certainly expected of them by their universities.

Figure 6 - Trend in the Number of Discovery Grant Holders

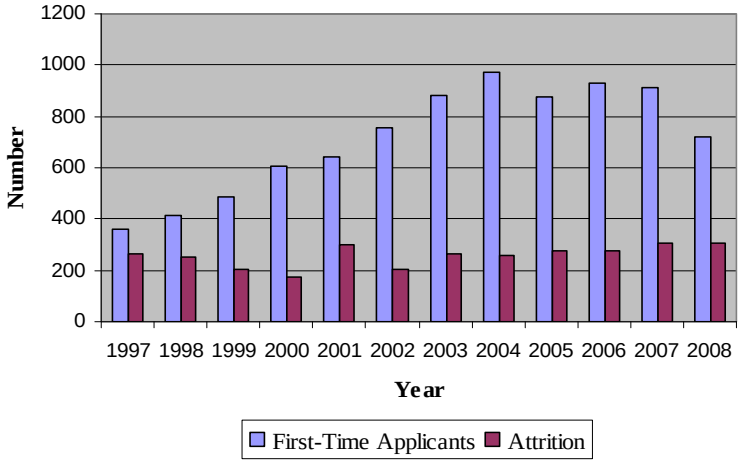


Source: NSERC

In recent years, the strong growth in the number of new DGP applicants has not been balanced by attrition of existing grantholders (Fig. 7). Attrition generally results from retirement, or from relocation outside Canada or to non-university sectors. As mandatory

retirement rules have been abolished and universities have increased the number of adjunct or emeritus appointments, it is common for researchers to maintain an active research program long after what used to be retirement age.

Figure 7 – Number of First-Time Applicants vs. Attrition in the DGP

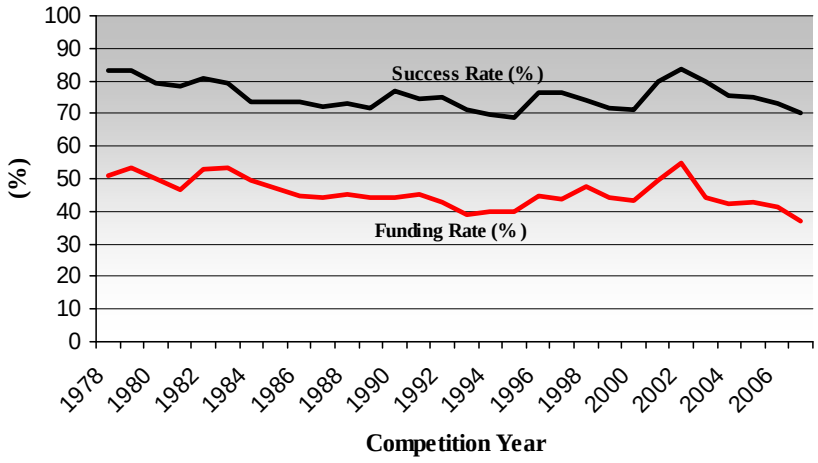


Source: NSERC

2.2 The "Success Rate"

The competition success rate in the Discovery Grants Program in 2007 was 70.2% – i.e., about seven in ten applicants received some DGP support (Fig. 8).

Figure 8 - DGP Funding Rate and Success Rate

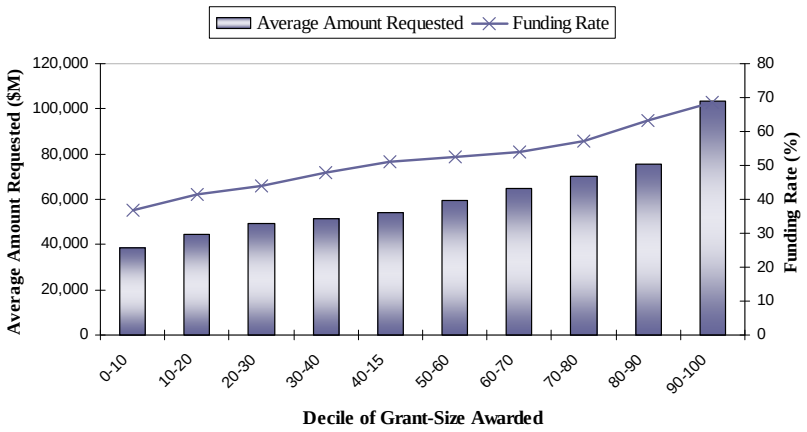


Source: NSERC

Applicants typically receive less than requested, with the effect that total funds ultimately awarded were only 38% of the total requested by all applicants in 2007, including the

successful and unsuccessful. This provides an important further perspective on the DGP "success rate". For established researchers[11], the funding rate increases with grant-size decile (Fig. 9). Those in the highest decile receive almost 70% of substantially larger requests compared to the 37% funding rate for grantees in the lowest decile.

Figure 9 - Average Amount Requested ($) and Funding Rate (%) *



* Established reseaerchers

Source: NSERC

The success and funding rates have remained relatively stable over time within a 15% band though they have declined somewhat during the past five years. The proportion of faculty members in the NSE disciplines who actually hold Discovery Grants is lower than the current 70% success rate in the DGP since, in practice, faculty members who fail to obtain a DGP award after one or two attempts will usually stop applying. It is believed that these faculty members obtain little, if any, research support from other sources since the holding of a Discovery Grant is informally regarded as a qualifying condition by most other Canadian research support programs in the NSE disciplines.

Comparisons of the DGP with Other Programs and Systems: When comparing the success rate and award size of the DGP with those of other types of research support, account must be taken of the following considerations (see also Appendix 2):

- **DGP provides long-term "baseload" support.** In a healthy research support system, there must be ways to effectively provide long-term baseload support for the majority of the community – including for new researchers, for training, and for strategic and applied

> The DG program is the backbone of the research capability in Canada since Canadian universities do not provide any built-in research funds as in Europe or Japan. Without it, many faculty members would not be competitive and would simply become teachers.[1]

[1] *Throughout the text are inserted short boxes, taken from submissions of researchers, administrators and others, that were typical of comments reviewed by the Committee and that illustrate certain observations or findings in this report.*

[11] Established researchers are those who have been funded for more than five years

research that follows from discovery. The DGP provides this broad base of support for NSE researchers in Canada. In other disciplines, and in other countries, broad research enablement is typically provided by a patchwork of mechanisms – e.g., funds provided through the university; from state/provincial agencies; private sector – rather than by the "headline" grant programs which are usually project-based and typically have relatively low success rates for individual applications. In these cases, the researchers' host institutions must maintain internal research funds to support their faculty members. This is the case in the US, for example, because it is known that many researchers will fail to obtain NSF grants. Similarly, in Australia, institutions internally provide support for new researchers so that they can be competitive in Australia's projects-based granting systems. At the University of Western Australia, for example, more than 60% of faculty members carry out research and supervise graduate students while only about 37% hold grants from the Australian Research Council.

- **Comparing success rate.** Only one DGP award may be held at one time, whereas other programs – e.g., in the CIHR – usually allow an investigator to hold multiple grants from the program at a time. This increases the effective success rate "per individual" as opposed to "per application". Quoting success rates "per award competition" obscures the fact that the ultimate success rate, on a "per individual researcher" basis, is higher for programs that allow investigators to hold multiple grants simultaneously from the same program. For example, the total average success rate in NSF competitions since 2000 has been about 24%. However, in the same time period the average success rate per principal investigator has been about 40%. Additionally, it should be noted that the NSF average success varies widely depending on scientific discipline and the type of funding opportunity. In many cases NSF is not the only, or even primary, funder of the discipline in US institutions.[12]
- **DGP supports direct costs only**. Discovery Grants support only the direct costs of research and cannot be used to support faculty salaries or research overhead of the host institution. This is in contrast with some countries' programs – e.g., of the National Science Foundation in the US – where grants may need to be larger than those of the DGP since they are often used to support some part of the salaries of the investigators. The grants may also be heavily "taxed" by the host institution to defray institutional overhead and the indirect costs of research. A portion of these funds may, at the discretion of the university, be returned to the researcher for flexible use. This would provide support analogous to a Discovery Grant but in a less transparent and more round-about way.

The NSF Experience

In August 2007, the National Science Foundation (US) published a report on the *Impact of Proposal and Award Management Mechanisms (IPAMM)* [11]. The study was partially motivated by a sharp decline in NSF's proposal success rates[12] and by its potential impacts on the nation's science and engineering capacity.

Since 2000, NSF has made a conscious effort to increase the average research award size, in order to ensure reasonable impact of the research supported. This strategy succeeded in raising the average award size by 41%, from $101.2K to $142.6K. At the same time, the number of proposals increased by 50% – from 20,000 to 31,000 – bringing the success rate from 30% in fiscal year 2001 to 21% in fiscal year 2006, despite a 44% increase in the NSF budget.

The quality of the proposals has remained high, but the success rate of highly-rated proposals (as per NSF's scoring system) has gone down from 76% to 62% in the period 1997-2006. The average number of unsuccessful proposals before an award is made has increased from 1.7 to 2.2. As a result more fundable, but declined, proposals are being revised and resubmitted. This is seen as a non-productive use of the time of Principal Investigators, reviewers, and NSF staff. The increase in workload has increased the reviewer burden.

Principal Investigators that are highly dependent on NSF funds tend to continue to submit proposals after repeated declines for a much longer period of time than do those with other funding sources (e.g. mathematics vs chemistry).

A widely-held belief is that, as success rates drop, reviewers become more conservative and less receptive to revolutionary ideas that challenge existing paradigms. This is thought to discourage Principal Investigators from submitting proposals containing potentially transformative ideas, and the whole system may tend to become less "high-risk." IPAMM found that NSF was, by far, the US agency to which the respondents would submit their transformative research ideas. The majority felt that NSF welcomed such proposals and that they themselves had recommended such proposals for funding. Nevertheless, NSF has appointed a new internal working group that is studying ways in which to be more proactive in attracting and supporting potentially transformative and interdisciplinary research proposals.

[11] http://www.nsf.gov/od/ipamm//ipamm.jsp

[12] NSF refers to the number of awards relative to proposals as funding rate. For consistency with terminology in respect of the Discovery Grants Program, this report uses the term 'success rate'.

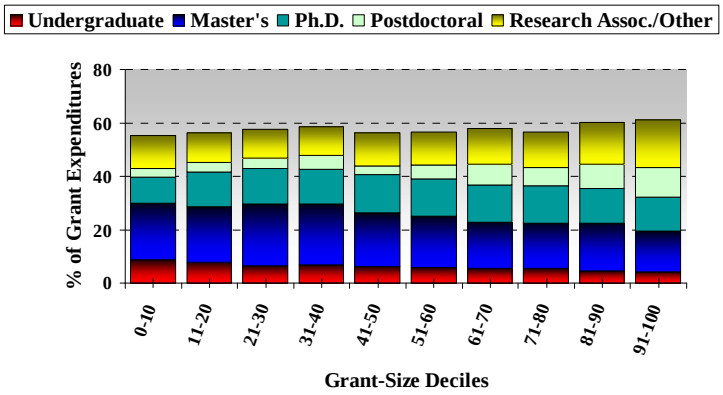
2.3 Support for Training of Highly-Qualified Personnel

A core objective of the Discovery Grants Program is to enable the training primarily of graduate students. The production of the highly-qualified people needed in today's knowledge-intensive economy is probably the most important payoff from the public support of research. Canada's investment in the DGP appears to be efficiently targeted in this regard.

Almost 60% of DGP funds go to support the training of students, postdoctoral fellows and research support personnel (Fig. 10). It should be noted that researchers with lower DGP awards allocate a larger proportion of their grants to undergraduates and Masters students than do those with larger awards, who on average spend more on postdoctoral fellows, research associates, technicians and other support personnel.

Most faculty members spend a significant portion of their DG on their students of all levels. Their capacity to train these students depends on the DG funding.

Figure 10 - DGP Expenditures on People, 2006-07



Source: NSERC

High-quality training requires time. There is a limit to the number of students that a researcher can supervise. The best [way] for Canada to increase the number of HQP in the NSE is to support a broad and diversified base of high-quality researchers.

Approximately 30,000 individuals, almost 90% of whom are students, receive some stipend support from Discovery Grants (Table 3). (A further 38,000 people are also involved in research undertaken by grantees but not supported by DGP funds).

Table 3. Estimate of Number of Highly Qualified Personnel

	Involved in DG Holders' Research	Supported through DG funds
Undergraduate	19,210	7,700
Master's	20,300	9,000
Doctorate	16,000	9,350
PDF	5,790	1,920
Research Associates	2,820	820
Technicians	3,220	940
Other	675	190
Total	**68,015**	**29,920**

Source: NSERC, based on online survey (2007)

3. Supporting Excellence Through Discovery Grants

The following four chapters address, in turn, the elements of the charge to the Committee, the first of which is:

> *To what extent is NSERC successful in supporting the best researchers at a world-class level through its overall suite of programs? To what extent is the research supported through the Discovery Grants program having an impact on the international scene?*

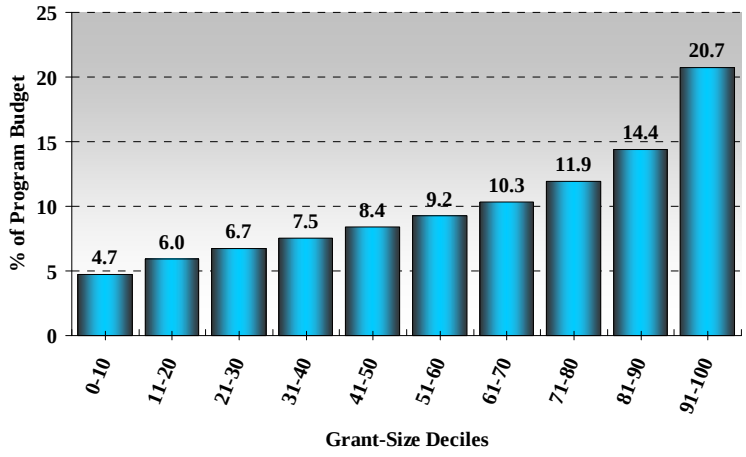
3.1 Supporting the Best Researchers at World-Class Levels

The Committee believes that the Discovery Grants Program, in concert with other NSERC and non-NSERC funding, has generally supported Canada's best researchers at an internationally competitive level. This conclusion is based on the experience of Committee members who are familiar with the university research support environments in the US, Europe, Australia and Canada. It is unfortunately not possible to make precise "apples to apples" international comparisons because of significant variation in the objectives and design of the various funding programs and because of gaps in available data (see Appendix 2). It is inappropriate, for example, to make simple comparisons of average grants across different programs without taking into account the many detailed aspects of the programs themselves – i.e., the fine print matters.

It is clear that DGP support is far from uniform across the range of grantees and the data suggest that **more meritorious research is more heavily supported**. For example, in

2005-06, the top 10% of the size distribution of Discovery Grants comprised nearly 21% of total funds awarded, and the top 30% received 47% of DGP funding. Meanwhile, the bottom 30% of the grant-size distribution accounted for only 17.4% of total DGP funds (Fig. 11).

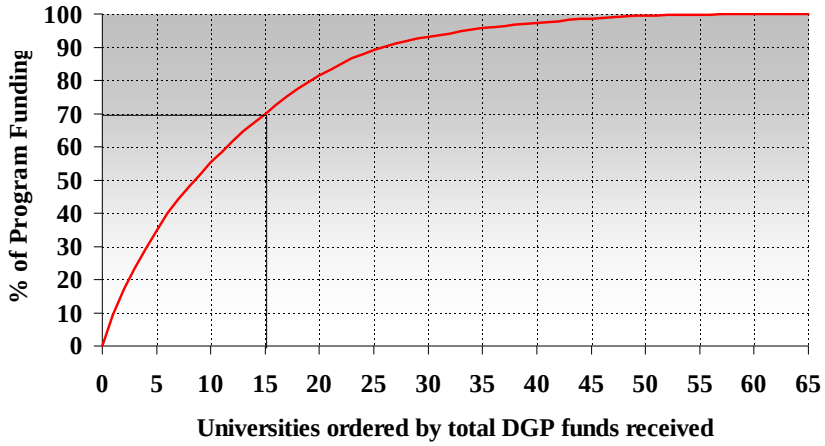
Figure 11 - Distribution by Grant-Size of DGP Budget, 2006-07



Source: NSERC

The distribution of DGP support by institution demonstrates that the awards are also concentrated at the leading research universities – e.g., researchers at the top 15 out of 65 universities (based on total DGP funds received by faculty) received 70% of DGP funds in 2005-06 (Fig 12). This concentrated distribution is essentially the same as seen in Australia where eight universities out of thirty-eight (or 21%) receive 70% of the external research funding obtained by universities.

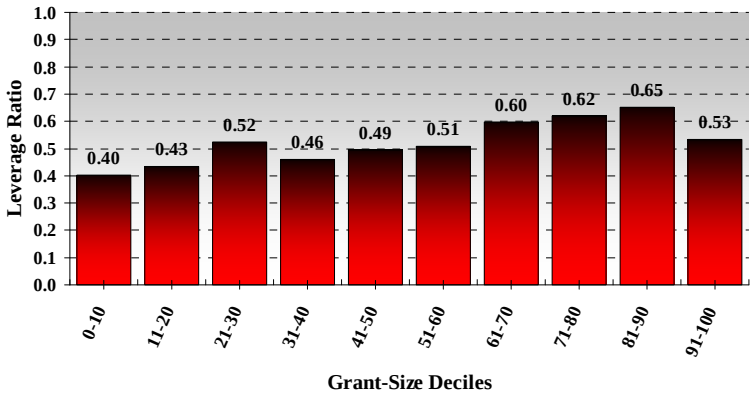
Figure 12 – Cumulative Distribution of DGP Funding by University, 2006-07



Source: NSERC

Base to lever funding. Holding a Discovery Grant builds credibility for the recipient, which increases the likelihood that one is able also to secure funding from other sources. Discovery Grant size alone is therefore not a valid measure of the total support available to top researchers. Award holders, on average, obtain 40% to 60% further funding from other NSERC programs to supplement their Discovery Grants, and it is the case (with a few exceptions) that the larger the Discovery Grant, the larger the "leverage ratio" (Fig 13).

Figure 13 - Leverage Ratio for Established Researchers, 2006-07 *



* Leverage ratio is the additional NSERC funding received by Discovery Grant holders expressed as a percent of the grant

Source: NSERC

Discovery Grants are also often supplemented substantially by non-NSERC sources – e.g., a recent on-line survey conducted by NSERC showed that DGP awards are leveraged overall about 2:1. It should be noted that different disciplines have substantially different abilities to access non-DGP and (especially) non-NSERC funding. For example; researchers in the biological sciences often have access to significant additional funding from the CIHR and from foundations that support research on individual diseases. For other disciplines (e.g., pure mathematics), such additional access is difficult or not available at all. For these disciplines the Discovery Grant is not a "grant-in-aid" – it is the only grant.

With Discovery Grants as foundations, the best researchers have taken advantage of NSERC's other programs, e.g., Strategic Grants, CRD Grants, Industrial Research Chairs, or Research Networks, and have been funded at the international levels.

It may be noted that the research in chemistry for which John Polanyi received the Nobel Prize was funded by Discovery Grants alone. Professor Polanyi has said that his Discovery Grants, because of the freedom that they afforded him, were indispensible in making possible his Nobel Prize winning work.

A recent review of the total research funding, from all sources, held by the top *one percent* of DGP award recipients – representing the top four grantees under each Grant Selection

Committee (103 researchers in all) – shows that the top Discovery Grant holders are able to leverage substantially greater overall support (Table 4). [13]

Table 4 - Total Research Funding of Discovery Grant Holders

GSC Group	All grantees Source: Survey of Grantees		Top 4 grantees in each GSC Source: File Review	
	Mean ($000)	Median ($000)	Mean ($000)	Median ($000)
Physical Sciences	$100	$60	$476	$320
Mathematical Sciences	$46	$25	$147	$124
Life Sciences	$118	$80	$225	$149
Engineering	$115	$60	$477	$362
Total	$100	$55	$347	$244

Source: NSERC

Some key points from this analysis are that:

- The top one percent of DGP grant holders have total funding that averages almost $350,000 annually, or roughly 3.5 times the total funding of the average DGP grantee. The averages vary substantially by major sub-discipline.
- For every $1.00 of DGP funding, the top researchers, on average, obtain $1.00 from other NSERC programs and just under $1.50 from non-NSERC sources.
- The top one percent of Discovery Grant holders were spread across 25 institutions, but just over half are at four universities – University of Toronto, University of British Columbia, McGill, and University of Alberta.

Despite overwhelming endorsement of the DGP by the natural sciences and engineering community, not all researchers surveyed by NSERC agree that the support for excellence is adequate. The Committee would note, however, that full support of an internationally competitive genetics lab, for example, should not be expected from a Discovery Grant alone. The evidence shows clearly that the best, and most expensive, Canadian research receives substantial support

> At a minimum, running an internationally competitive experimental genetics lab, using molecular biological techniques, costs about $200,000 per year… The average Discovery Grant of around $30,000 per year compares poorly with this threshold.

[13] Source: Special study conducted by NSERC for the International Review Committee. (One file was unavailable for review). Data reported in the file review are for the most recent Discovery Grant Applications.

beyond the DGP. But the Discovery Grant provides a secure five-year base that ensures consistent support for graduate training and the flexibility for the grantee to pursue unanticipated but promising avenues of discovery, including interdisciplinary collaborations.

Discovery Accelerator Supplements. NSERC has recently established, out of new funds received in federal Budgets, a supplementary award – the Discovery Accelerator – to support a select group of DGP grantees whose research shows exceptional promise of rapid and significant progress. The Accelerator Supplement is to enable these researchers to "seize the moment." The Accelerator is a three-year award of $40,000 per year, on top of the individual's Discovery Grant. NSERC currently makes available 100 new Accelerator awards each year which, given their three-year duration, would be held by up to 300 individuals when the awards are fully phased in. The Accelerator appears to be an effective way to amplify the support of excellence and respond to unpredictable opportunities for significant research advances.

3.2 International Impact of Canadian Research

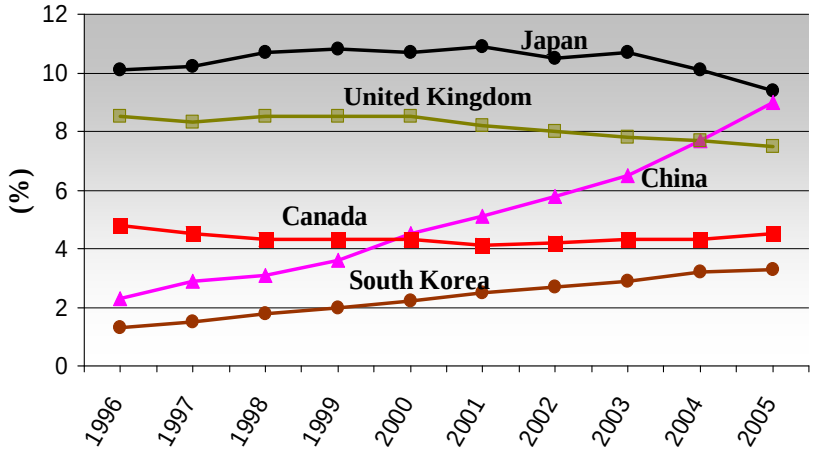
While the best Canadian researchers in the natural sciences and engineering appear to be supported at internationally competitive levels, the question remains as to what impact the research supported by the DGP and other "leveraged" sources is having on the international scene. **The Committee believes that Canadian research in most NSE disciplines is of high quality as gauged by citation intensity, which is arguably the best gross indicator of impact.** Canada's strength is also unusually broadly based, although improvements are clearly possible in individual fields[14].

It is of course impossible to isolate the specific influence of the Discovery Grants Program on the quality and impact of Canadian research. But, given that the DGP is NSERC's primary source of support for discovery research – whether directly or by leveraged access to other funding – it is reasonable to infer that this program is a key driver of Canadian academic research publications in the NSE disciplines, and these publications are the primary channels through which international impact is conveyed.

Quantity of Canadian publications. The world share of NSE publications for most countries, including Canada, has remained relatively stable over time (Fig 14). The share of the US, by far the world leader, has declined somewhat by from 35% in 1990 to about 29% in 2005. The emergence of a few countries as major performers in research (notably China and South Korea) is putting competitive pressure on established countries to keep pace.

[14] See also David King, *The Scientific Impact of Nations*, **Nature** 430, pp 311-316.

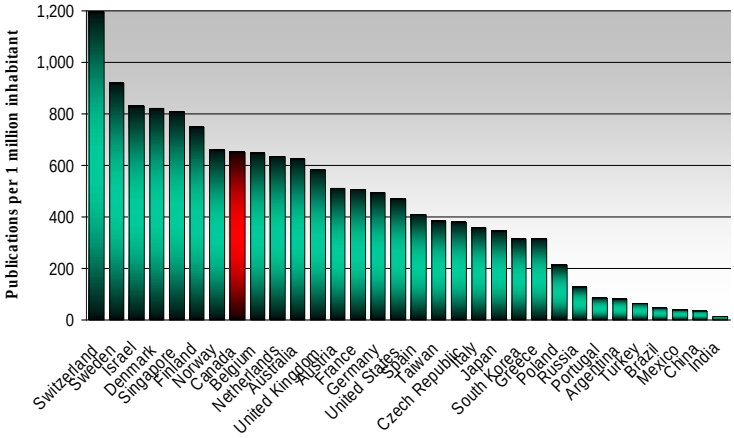
Figure 14 – World Share of ISI Publication in NSE



Source: Observatoire des sciences et des technologies

Canadian NSE publications in 2005 represented 4.5% of the world total, rising from about 4.1% in 2001. This places Canada seventh world-wide in absolute number of NSE publications, behind the US, Japan, China, Germany, the UK, and France. Viewed in relative terms, Canada's publication rate per capita ranks first among G-7 countries (Fig. 15) and eighth worldwide. Significantly, Canada ranks fifth in the world in publications per publicly-supported researcher.

Figure 15. Per Capita Output of Publications in the NSE, 2005



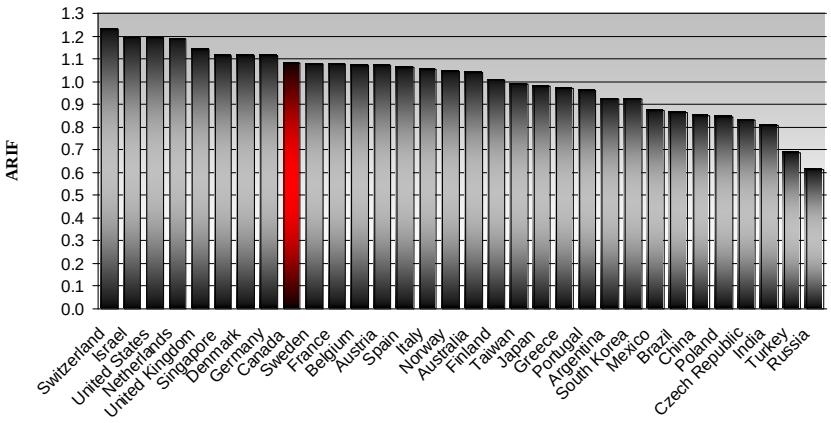
Sources: Observatoire des sciences et des technologies, OECD, 2005 CIA World Fact Book. Only includes countries with at least 3,000 articles in the NSE in 2005.

Note: the Swiss figures include publications from CERN

The great bulk – roughly 85% – of Canadian NSE publications are produced by the university sector, with research hospitals accounting for most of the remainder. These are the institutions served by the Discovery Grants Program. About 45% of Canadian NSE publications are co-authored with international researchers, indicating that Canadians are well-integrated in global research networks.

Quality of Canadian NSE Publications. Research impact depends both on the volume of publication and on its *quality*. The most widely accepted measure of publication quality overall is the Average Relative Impact Factor (ARIF). The ARIF is calculated by first assessing an impact factor for each scientific journal based on the average number of citations received by articles in that journal. If researchers from a particular country, and in a given field, tend to be published in "high impact" journals (as determined by citation intensity), the country receives a relatively high impact factor for the field. If a country's ARIF is greater than 1.0 for a particular field, it means that its researchers have relatively more publications in highly-cited journals than the world average in that field. With an ARIF of about 1.09 for NSE disciplines, Canada was ranked ninth overall in 2005 – and fourth among G-7 countries (Fig. 16).

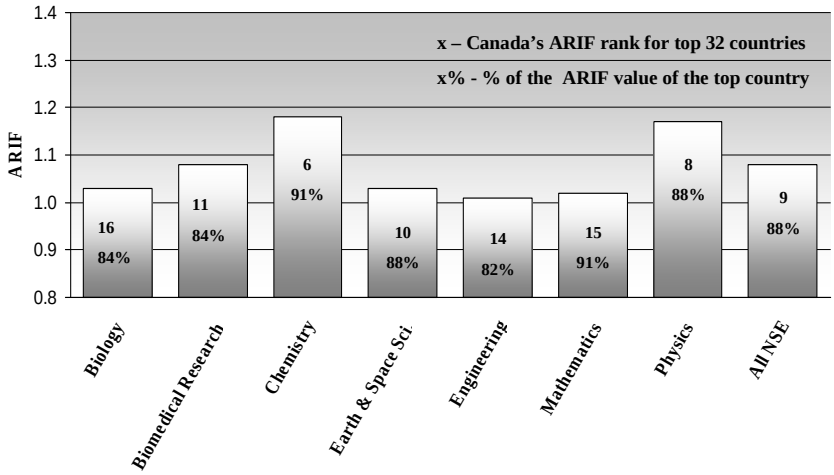
Figure 16 - Average Relative Impact Factor (ARIF) in the NSE, 2005



Sources: Observatoire des sciences et des technologies. Only includes countries with at least 3,000 publications in the NSE in 2005.

The ARIF data also show that Canada's system produces a relatively even quality of research across the seven major NSE sub-fields with Canada ranking from 6th to 16th among the 32 countries studied. Chemistry and Physics are areas of particularly high quality Canadian research. In none of the sub-fields were Canada's ARIF indicators below the 32-country average (Fig.17).

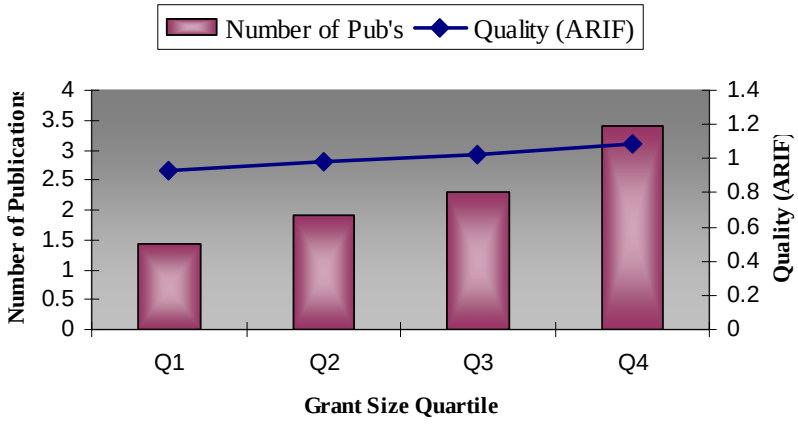
Figure 17 – Canada's ARIF in NSE Sub-Fields, 2005



Source: Observatoire des sciences et des technologies

The Committee examined evidence as to both the volume and quality of research publications by Discovery Grant holders (Fig. 18). Perhaps surprisingly, there is relatively little variation in average publication quality (proxied by ARIF) as a function of grant-size[15]. These data suggest that even small Discovery Grants can support high quality research across the broad base of grantees, while the larger grants result, as expected, in a higher rate of production, on average, though the gradient is much less pronounced in some disciplines.

Figure 18 – Publication Volume and Quality by Grant-Size Quartile (Average across all GSCs)



Source: NSERC estimates, OST.

[15] A statistically significant difference in ARIF across the grant-size quartiles exists for only a few GSCs – e.g., chemistry, plant biology, physics and mathematics.

4. Balancing Excellence and Diversity

The second element of the charge to the Committee asks:

> *What should be an appropriate balance between the following two objectives of the Discovery Grants program: "promoting and maintaining a diversified base of high quality research capability in the natural sciences and engineering in Canadian universities" and "fostering research excellence"?*

The Committee believes, based on the evidence presented in the last section, that the Discovery Grants Program generally strikes an appropriate balance between fostering excellence and maintaining a diversified base of research capability across the NSE fields, though there are opportunities for improvement as outlined in Section 6 below.

The Committee is concerned that there may be considerable misunderstanding about the role and nature of the Discovery Grant Program. The evidence reviewed by the Committee demonstrates that any perception that the DGP is flawed because of a "high success rate and low grant value" is an inaccurate reading of the actual situation.

Reference is made in particular to the Committee's analysis in Section 2 (p. 20,21) of factors that need to be considered when comparing the DGP with other programs in Canada and abroad.

The Committee believes that it is important that NSERC describe the multi-objective role of the DGP, and how it fits within the suite of NSERC programs to promote excellence while also ensuring essential support for a broad spectrum of quality research and state-of-the-art training for student researchers in all NSE fields, the majority of whom will pursue their careers outside the academic sector.

5. Suitability of the DGP in the Canadian Context

The third element of the charge to the Committee asks:

> *To what extent is the philosophy of the Discovery Grants program suited to the Canadian context and Canada's needs for research results and highly qualified personnel?*

The Committee believes that the Discovery Grants Program is an exceptionally effective model for supporting Canadian research in the NSE fields.

Emerging problems are more easily dealt with when basic research has already been done. In recent years, our ability to respond to problems, such as the mountain pine beetle or SARS, has depended on pre-existing research programs.

The DGP is well-suited to the Canadian context since it plays a key role in fulfilling the country's need both for fundamental research of world-class quality and for highly-trained people across the range of disciplines needed to support a knowledge-intensive society. More specifically, the Committee believes the DGP is well-suited for Canada, principally for the following reasons.

- The philosophy and design of the Discovery Grants Program, for reasons cited throughout this report, make it suitable not only for Canada's circumstances but also for those of university research environments in many other countries.

- In Canada's particular case, where the competition from US universities for top talent is omnipresent (and increasingly as well from other research institutions worldwide) the DGP provides some unique and important attractions for individual researchers – e.g., flexibility as to research directions; a low burden of proposal submission due to the DGP's reasonably high success rate and (typical) five-year tenure; an environment for reliable medium-term support of graduate students. This makes Canada more attractive in the global competition for top research talent.

> The DG program has been extremely successful for new researchers, particularly when contrasted with the funding situation in the United States for new researchers. In fact, the DG program, along with 12 months of academic salaries, has been one of our best recruiting tools.

- The philosophy and design of the DGP are adapted to the Canadian realities of (a) a far-flung geography and correspondingly wide variation in economic conditions and population concentration; and (b) a commitment to a degree of regional balance in all federal endeavours. These factors explain why the word "diversified" features in the original objectives of the DGP.

> Good researchers can rely on getting enough money to fund a few students, so they know that they will be free to pursue their basic research program come what may. This is extremely important to people who live for their research. The discovery grant system is one of the main reasons I came back to Canada.

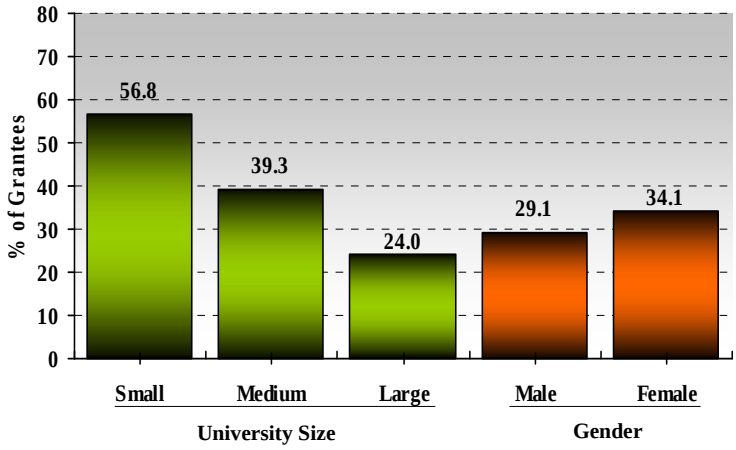
Based on the evidence reviewed by the Committee, the diversity objective has been well-balanced by the program's "excellence" objective though NSERC must be vigilant to ensure that the balance continues to be appropriate as conditions in the international research environment continue to evolve. (The innovative Accelerator Supplement is a good example of keeping abreast of the times. The Committee makes some further recommendations to improve the DGP in Section 6 below)

Diversity of support. The relatively high success rate of the DGP(about 70% in 2007) provides a base level of support for good quality researchers across a broad spectrum of fields. It is noteworthy that in some fields virtually all faculty members must have an active research program in order to effectively supervise students. Engineering was singled out in this regard, with implications for effectively meeting the needs of industry. The ability of the DGP to tailor support to a broad base of researchers is particularly important in regions and provinces where the availability of other sources of funds (e.g., from the private sector) is limited. The program also provides effective support across seniority levels and gender.

Although research quality is not tightly linked to the size of a Discovery Grant (recall Fig. 18), the Committee believes that, inevitably, a significant intentional reduction in the DGP success rate – in order to concentrate funds on fewer researchers – would have a disproportionate impact on those currently receiving smaller grants. This would result in reduced research support in the smaller provinces and in small institutions. For example, almost 57% of Discovery Grants held by faculty in small universities were in the bottom 30% of Discovery Grants ordered by GSC and by size[16]. Only 24% of DGP awards to faculty in large universities were in the lowest 30% of the grant-size distribution. It was also the case that, about 34% of female grantees (versus 29% of males) held awards in the smallest 30% (Fig 19). While female representation in academia is increasing, women tend to be concentrated in the lower academic ranks and have had relatively fewer grant renewal opportunities to increase their awards.

> A more restrictive funding system would utterly destroy the capacity of many strategically located universities in smaller centres to fulfill their regional mandate. Academic expertise is needed in remote areas to conduct research on regional issues, provide master's level training for local industry and government, and perform vital public advocacy roles.

Figure 19 – Percentage of Grantees by University Size and Gender in the 0-30% Decile Range of GDP Award Size (2006-07)



Source: NSERC

Consider the following scenario. There were about 2,100 established researchers in the three lowest deciles of the grant-size distribution in 2006-07. Their grants totalled 17.4% of the DGP budget or about $38 million. Suppose, for the sake of argument and illustration, that these funds were not available for the smallest 30% of grants but were instead allocated to the 2,850 new and established researchers in the top three deciles. As a result, the average grant of the most well-funded 30% would increase by 29% or $13.4K. Although such a

[16] In this categorization, the "small" universities are those whose faculty have received less than $3M in total from the DGP over the past five years. The "large" universities are the 13 top research-intensive institutions.

reallocation increase would not be insignificant, the relative benefit to those with the top Discovery Grants (who also usually have substantially greater funds from other sources) would, in the Committee's opinion, be less important than the loss to Canada were many of those with smaller grants to be deprived of the ability to conduct good research and thus provide advanced training to thousands of students. In fact the Committee believes that Canada could ill afford to forego the talent of such large numbers of researchers, the students' skills they develop, and the undergraduate students and Masters' students they attract to research. In particular, it should be noted that well-trained undergraduates and Master's students from smaller Canadian universities, who are often supported with smaller DGP awards, are an important source of talent for the advanced graduate programs of Canada's major research universities.

A primary reason for returning to Canada from New Zealand was the relatively high success rate of the DG program. In fields such as information systems, much can be accomplished with relatively little money and a wider spread of funds is important in attracting researchers.

6. Improving the Discovery Grants Program

For reasons explained in the foregoing sections, the Committee believes that the DGP has generally been remarkably successful in achieving its objectives and that those objectives are appropriate for Canada. But no program is ever perfect and circumstances are never static. The Committee believes that the DGP can be even better and therefore addressed to itself the fourth element of the charge:

How could the Discovery Grants Program be improved?

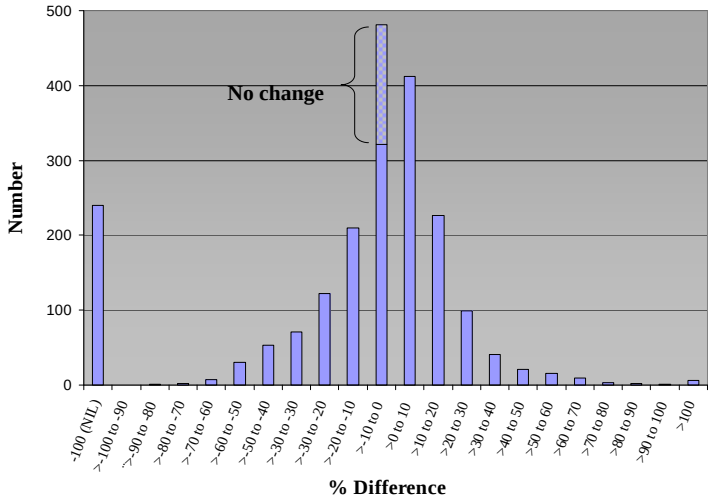
6.1 Recommendations

The Committee concluded that the DGP has some structural and operational weaknesses that inhibit its ability to fully achieve the mandate to support research excellence and training of highly qualified personnel. The Committee therefore recommends as follows.

1. An applicant's previous Discovery Grant should not be the starting point for a new grant. There are some indications that Grant Selection Committees (GSCs) tend to rely extensively on the amount of the previous grant and are conservative in making changes to a given individual's award from one funding cycle to the next. In essence, the value of a researcher's new award is usually within a small percentage of the previous one. For example, about 44% of grant renewals in the 2007 competition were within 10% (up or down) of the applicant's previous grant (Fig. 20). Although this reflects, in part, the fact that many established researchers sustain a roughly constant level of research quality and productivity for much of their careers, such 'inertia' may slow the decline in the grants of researchers whose productivity is decreasing and, in effect, tie up funds that otherwise could permit a more rapid ramping up of the most deserving younger researchers. While the Accelerator Supplements will help by injecting much needed funds for a limited number of exceptional rising stars – at least for the three-year duration of these awards – the

Accelerators alone cannot address the needs of thousands of very active researchers, particularly those hired in the past ten to fifteen years.

Figure 20 – Percentage Difference Between New and Previous Grant (All Renewal Applicants, 2007 Competition)



Source: NSERC

To eliminate any remaining inertia in the awards process, and thereby to increase the funds available for strong proposals, the Committee recommends that:

a. Each GSC should first rate the proposals under consideration according to *merit* criteria[17] and *without* reference to the proposer's prior grant amounts, requested budget or the need for funds criterion.

b. The merit rating would assign proposals to a number of "bins" – e.g., "Must fund", "Fund if resources are available", "Possibly fund", and "Do not fund" – perhaps using some measure of forced distribution to prevent rating inflation. (Proposals that fall near the margin of a bin should, if possible, be given a specific priority ranking to facilitate final recommendations by the GSC.)

c. NSERC should review its selection criteria to include elements such as "the potential for the research to be transformative".

d. In order to ensure adequate support for "early career" researchers – i.e., those who are within some appropriately specified period after completion of their final degree, and have not previously received a Discovery Grant – the proposals of early-career researchers should be rated based on their potential for research impact and contribution to training and in a "bin" structure parallel to that used for established researchers.

> Giving small discovery grants to many people … ensures that there is modest funding for all of the good researchers. Younger researchers are often very hard to assess, especially if they have the original ideas that are going to put people like us out of business.

[17] These are the first three of the selection criteria listed in Table 2.

e. Only after all proposals have been merit-rated in bins, should the GSCs consider the funding level to be allocated to proposals, based on the requirements set out in the proposal budget. In this regard, NSERC should better define the intent of the existing "Need for Funds" criterion. A separate allocation should continue to be set aside to fund early-career researchers. The current NSERC target guideline of 50% success for the latter group is reasonable, subject to assurance of high quality.

The Committee also believes that the NSERC guideline that an above-average grant cannot be cut by more than 50% could contribute somewhat to the system's inertia[18]. (The intent of the guideline is commendable – i.e., to reduce the impact of an abrupt loss of funding on the research personnel paid out of the grant.). The Committee recommends that:

f. NSERC should eliminate the 50% maximum reduction rule for holders of above-average grants. Reduction decisions should be strictly merit-based (as above) without constraint on the discretion of a GSC except that consideration will need to be given to the impact of severe grant reductions on existing graduate students – e.g., to allow up to a two-year phase down of such support.

2. Increase the number of Discovery Accelerator Supplements. The Committee believes that the Accelerators are a particularly effective way to encourage excellence by helping researchers with unusually promising and timely ideas to "seize the moment". The Committee believes that NSERC's current plan to award 100 (three-year) Accelerator Supplements annually – at a cost of $12 million over three years – is too modest an investment in view of the potential of these grants to substantially increase the impact of Canada's most promising research ideas.

Accordingly, the Committee recommends that:

a. The annual limit on new Accelerator grants be doubled to 200, which would eventually result in 5% to 6% of Discovery Grant holders also holding Accelerators. This increase should not be at the expense of existing programs but rather continue to be from new funds received by NSERC.

b. NSERC retain its existing policy of requiring that applicants for an Accelerator enter the DGP competition for the current year. This implies that those who already have a Discovery Grant must re-compete and therefore run some risk of losing their *existing* grant. (Such candidates are only considered for Accelerators on the recommendation of their university's V-P Research). The Committee does not believe that existing awards should be guaranteed – i.e., reinstated if the applicant ends up with less than his or her existing Discovery Grant after the new competition. If the application has merit, there will be little risk of a reduced grant.

The Committee anticipates that the injection of Accelerator funds will be very beneficial to those receiving an award and recognizes the pressure on the program budget once those who have been "Accelerated" for three years return for their next Discovery Grant. The

[18] Normally, above-average grants reduced by 50% are awarded for one year, and may be subsequently cut further if the researcher does not address the GSC's concerns.

Committee therefore strongly supports NSERC's commitment to carry out periodic evaluations addressing the short-, mid-, and long-term impacts of the Accelerator program, including the way in which adjustment to the expiry of individual Accelerator Supplements is handled.

3. Revise the GSC structure. The issue of GSC restructuring is being addressed by another advisory group (chaired by Professor Adel Sedra). Nevertheless, certain aspects of GSC structure have implications for the Committee's mandate. In particular, the Committee would endorse proposals to:

a. Cut the number of GSCs from the current 28 roughly in half. This would facilitate assessment of transdisciplinary proposals and, by virtue of substantial structural rearrangement, could be expected to reduce any "inertial" tendencies implicit in the long-standing existing GSC set-up.

b. Increase both the number of GSC members and proposal reviewers who are based outside Canada. Currently only about 8% of 330 GSC members and 25% of reviewers are located outside Canada. External GSC members and reviewers – to the extent they may contribute a broad and objective perspective – are particularly valuable when ranking proposals by merit. The external perspective thus also works to diminish the risk of award inertia and unwarranted bias in favour of well-established grant applicants. Although it will be a challenge to increase the number of GSC members who are based outside Canada, roughly doubling the current proportion to about 15% would be an appropriate target. The challenge relates to the high workload associated with GSC membership. NSERC therefore needs to streamline the process to make it more attractive for non-Canadians to participate.

c. Ensure that every DGP proposal has at least one reviewer from abroad providing a written report.

4. Increase support for training of highly-qualified personnel. There is an international "talent war" to attract the best trainees. While recognizing that most research trainees have access to support additional to their supervisors' DGP awards[19], the Committee believes that the training aspect of NSERC's suite of programs should be further strengthened. The announcement in the most recent federal budget to create a prestigious new class of doctoral scholarships – the "Vanier" scholarships – is therefore welcome. These will provide an annual stipend of $50,000 for three years for 500 (Canadian and international) students per year across all fields. The Committee believes there is also a need to encourage more postdoctoral fellows from abroad – who are not currently eligible for *direct* NSERC support – to come to Canadian universities. (Foreign PDFs and students can be supported via Discovery Grants at the discretion of the grant holders.) Postdoctoral fellows provide very cost-effective leverage of research funds and their experience in Canada may either lead them to stay, or at least to foster on-going relationships between Canadian researchers and those in their eventual location of work. The Committee also noted the impact of the Canada

[19] This support is provided for example, by NSERC's direct scholarships and fellowships (which provide support to about 9,000 annually), but also by teaching and research assistanceships from the institution. But it is noted that TA- and RA-ships may significantly encroach on the time to do much research.

Graduate Scholarships in supporting 1,500 graduate students in the NSE, thus, in effect, stretching the Discovery Grants for the supervisors of these students.

The Committee recommends that:

a. Canada should strengthen its ability both to retain larger numbers of Canadian PDFs in Canada (currently, about half of NSERC-supported PDFs are located outside Canada), and to attract international PDFs. Specifically, the Committee endorses NSERC's recent efforts in this area through the new CREATE programs (to support principal investigators in developing a critical mass of highly-qualified personnel (HQP) within their research teams, and with no restrictions on the nationality of HQP.

b. New mechanisms should be developed to encourage PDFs who study abroad to return to Canada – e.g., through research support that is aimed directly at the early career stage to support researchers in Canadian institutions as they transition to research independence. This could, perhaps, be modeled after the NIH "Pathways to Independence" awards program, the NSF CAREER awards, or the "Future Fellowship" of the Australian Research Council.

5. At a minimum, the DGP should be funded at a level sufficient to keep the average grant-size from decreasing in real (constant dollar) terms. The average DGP award is modest, at a little more than $30,000 (in 2006-07), and has been declining recently in real terms largely as a result of the applicant pressure generated by the wave of faculty renewal in universities across Canada. In the opinion of the Committee, the erosion of the value of the average grant is a more serious problem than the 70% success rate. The great virtue of the DGP in providing researchers the essential freedom to explore and discover should not be undermined in favour of more highly-targeted programs. While the Accelerator Supplement will indirectly, and in the short term, relieve some of the pressure on the DGP, other options to enhance the average grant need to be explored.

6.2 Further Observations

The Committee considered whether there should be a minimum size of Discovery Grant – e.g., to ensure support of at least one graduate student. (This might be based on research costs in the field and ability to leverage other funding.) But in view of the many specific factors that would bear on setting an appropriate minimum, **the Committee concluded that there should *not* be a uniform NSERC-mandated lower limit on grant-size**. It may nevertheless be appropriate to establish minimum grant-sizes based on discipline-specific factors and thus varying across Grant Selection Committees.

The Committee also considered the suggestion that upper limits be placed on the size of grants. **The Committee concluded that there should not be an upper limit – either absolute or varying by discipline – on the size of grants.** This would limit a GSC's discretion to support outstanding proposals. The individual GSCs are in by far the best position to weigh all the factors in deciding the best allocation of limited funds.

7. In Conclusion

The Committee believes that the DGP is an unusually effective and efficient method of research support, particularly in the Canadian context. Knowledgeable observers in other countries have generally praised its features – in particular, the program's encouragement of an innovative and flexible approach to research; its longer-term, and thus more reliable, support of graduate training; and its efficiency from the perspective of the researcher who, in most other programs, must spend an inordinate amount of unproductive time in a continuous cycle of proposal submissions.

The evidence before it convinced the Committee that: (a) the relatively high success rate of DGP applications is *not* incompatible with, and in fact encourages, a high degree of research excellence across a broad range of fields; (b) the best researchers are able to use support of a Discovery Grant as a base to lever an internationally competitive level of funding from other sources; (c) the broad base of DGP grants serves to sustain an important level of research capability and student training across the NSE disciplines and throughout Canada and thus contributes significantly to meeting the national needs for research results and highly-qualified people; and (d) the Discovery Grant Program is therefore an exceptionally productive investment and thus deserves additional funding to ensure that the value of its grants keeps pace with the growing opportunity.

Appendix 1: Overview of NSERC Programs

Program	Purpose	Budget ($M) 2007-08	% of Total
PEOPLE Programs for scholarships and fellowships that support students as they prepare to become Canada's next generation of experts			
Undergraduate Students Research Awards	Stimulate students' interest in research in the natural sciences and engineering and encourage them to undertake graduate studies and pursue a research career in these fields	19.2	2.1
Canada Graduate Scholarships	Ensure a reliable supply of highly qualified personnel to meet the needs of Canada's knowledge economy	37.5	4.1
NSERC Postgraduate Scholarships		50.8	5.6
Industrial Postgraduate Scholarships	Encourage scholars to consider research careers in industry and contribute to strengthening Canadian innovation	6.0	0.7
Postdoctoral Fellowships	Secure a supply of highly qualified Canadians with leading-edge scientific and research skills for Canadian industry, government and universities	17.0	1.9
Industrial R&D Fellowships	Encourage recent Ph.D. graduates to gain experience and seek careers in Canadian industry; facilitate the transfer of expertise and technology to industry; and provide an opportunity for Ph.D. holders seeking university careers to gain experience in industrial research and development	5.0	0.5
Northern Research Internships	Encourage senior undergraduate and graduate students and postdoctoral fellows to spend extended periods in the Canadian North and subsidize the high costs associated with activities in the North	0.1	0.0
Programs of chairs to create and support faculty positions. These ensure the availability of experts in a wide variety of fields to train the next generations, perform research, and act as expert resources for other parts of the innovation system.			
Canada Research Chairs	Attract and retain some of the world's most accomplished and promising minds	133.2	14.6
Industrial Research Chairs	Create, or build on existing strengths to achieve, the critical mass required for a major research endeavour of interest to industry and/or develop new fields for which there is an important industrial need; and expose graduate students and postdoctoral fellows to research challenges unique to industry	21.5	2.4
Northern Research Chairs	Re-build a vibrant community of researchers interested in research in the Canadian North; contribute to the body of knowledge in fields of northern natural sciences and engineering; and build meaningful partnerships with Northern	1.3	0.1

	communities		
Chairs for Women in Science and Engineering	Increase the participation of women in science and engineering and provide role models for women considering careers in these fields	5.2	0.6
Chairs in Design Engineering and in Environmental Design Engineering	Improve the level and quality of design and environmental design engineering activity within Canadian universities	1.2	0.1
Programs celebrating excellence, research achievements and research partnerships with industry, and promoting a science culture in the Canadian public:		2.2	0.2
Centres for Youth, Science, Teaching and Learning (CRYSTAL)	Increase our understanding of the skills and resources needed to improve the quality of science and mathematics education (K-12) and of the best ways to enrich the preparation of young Canadians in these foundation subjects.	1.0	0.1
PromoScience	Promote science and engineering to Canadian youth and increase the numbers of students who pursue studies and consider careers in science and engineering	3.4	0.4
DISCOVERY Programs that support the conduct of basic research and ensure Canada's on-going involvement in the generation of knowledge, new ideas and the capacity to build on the advances of knowledge made elsewhere			
Discovery Grants	***Promote and maintain a diversified base of high-quality research capability in the natural sciences and engineering in Canadian universities; foster research excellence; and provide a stimulating environment for research training.***	**325.1**	35.6
Discovery Accelerator Supplements	***Accelerate progress and maximize the impact of outstanding research programs.***	**3.1**	0.3
Research Tools and Instruments	Support the acquisition of new research instruments and equipment and in so doing foster and enhance he discovery, innovation and training capability of university researchers	12.6	1.4
Special Research Opportunity	Support or develop unique, emerging research opportunities that are timely, urgent, high-risk or have a strong potential for breakthrough that will be of substantial benefit to Canada	11.1	1.2
Research Capacity Development in Small Universities	Eliminate some of the barriers to increased research productivity in small universities and help these institutions build the foundations for further success in this research	2.2	0.2
Major Resource Support	Ensure that major regional and national research resources remain in a state of readiness for academic users	35.2	3.9

INNOVATION Programs that accelerate research in areas of strategic importance to Canada			
Strategic Projects Strategic Networks Strategic Workshop	Generate new knowledge/technology in key areas with the strong potential to strengthen Canada's industrial base, generate wealth, create employment, and/or influence Canadian public policy; and enable the transfer of knowledge/technology and expertise to Canadian-based companies that are well positioned to apply the results for economic gain or to government organizations to strengthen public policy	86.6	9.5
Collaborative Health Research Projects Program	Support projects that facilitate the transfer of new knowledge in the natural sciences and engineering into applications that will benefit the health of all Canadians (financed jointly by NSERC and CIHR)	3.3	0.4
Programs that support the productive use of knowledge through partnership projects where university researchers help to solve problems or find answers to issues raised by companies.			
Collaborative R&D Grants	Support focused university-industry collaborative research projects that have the potential to result in industrial or economic benefits to Canada and offer training opportunities for students in areas relevant to industry	53.1	5.8
Research Partnerships Agreements	Build strong linkages and create synergy between the private sector and researchers in universities and federal institutes	25.0	2.7
Programs that provide resources and experts to accelerate the process of transferring knowledge and technology to the user sector			
Idea to Innovation Program	Accelerate the pre-competitive development of promising technology and promote its transfer to Canadian companies	5.8	0.6
Intellectual Property Mobilization	Accelerate the transfer of knowledge and technology residing in Canadian universities and hospitals for the benefit of Canada (tri-council program - NSERC, CIHR and SSHRC)	3.4	0.4
Networks of Centres of Excellence	Support focused national research networks involving managed and coordinated interdisciplinary projects and themes (Managed jointly by NSERC, SSHRC, CIHR, and Industry Canada)	40.2	4.4
General support		0.9	0.1
	Total	**912.1**	**100.0**

Appendix 2: Features of Some Major Research Support Programs in Canada and Abroad

Agency Program	Structural Features
NSERC Discovery Grants	Funding for a program of research with both short- and long-term objectives Researchers can only hold one such grant at any given time and cannot apply for supplemental funding from the DGP Almost all grants are awarded to individual researchers Average grant is about $30K p.a.; normal duration is 5 years Success rate around 70-75% Overall average funding rate of 40% (for funded applicants: from about 40% for the lowest decile of grant level to 70% for the highest decile) Cost to grantee for one graduate student: up to $22,000 (some universities may add tuition scholarship)
NSERC Project Grants	Funding for specific projects with short-term objectives and identified deliverables Researchers can apply for and hold multiple grants concurrently Most grants are awarded to teams Average grant varies by program but is generally more than $100K p.a.; duration is generally 3 years Success rate generally between 25 and 40% Funding rate is high (over 95%)
CIHR Operating Grants	Funding for specific projects with short-term objectives and identified deliverables Researchers can apply for and hold multiple grants concurrently (2 competitions per year) Most of the grants are awarded to individuals (60%) Average grant of $125K p.a., for up to 5 years (since 2005, steady increases from $95K) Success rate in the range of 20-35% since 2000 ("fundable" rate of 30-60%) Funding rate of 75-85% in recent competitions
SSHRC Standard Grant	Funding for a program of research (however, continuity of funding over time is rare) Grants can be held by individual researchers or teams Average grant of about $30K p.a. (up to $100K p.a. but not totalling more than $250K in a three-year period), for up to 3 years Success rate around 40%
Australian Research Council Discovery Projects	Support projects with specific objectives to be achieved within the project timeframe A researcher may be chief investigator on two active Discovery Projects (can be co-applicant on others) Often are team projects Success rate of 25% Average grant of about $91.3K[20] p.a., for up to 3 years Cost to grantee for one graduate student about $45,000 (including tuition)

[20] All amounts in this table have been converted into Canadian dollars

U.K. Engineering and Physical Sciences Research Council Responsive Mode Grants	Support projects with specific objectives to be achieved within the project timeframe Generally awarded to teams Success rate of around 32% Grants may vary from small grants to one million pound (amounts difficult to compare now that UK has adopted the full cost of research – i.e., direct and overhead costs) Cost to grantee for one graduate student: C$25,100, plus tuition (paid to the university)
Germany Deutsche Forschungsgemenischaft Individual Research Grants	Support projects, but generally only one Individual Grant may be held at a time Success rate of about 50% Average grant of about $64K p.a., generally for 3 years; covers the direct costs of research Cost to grantee for one graduate student: $45K
Swedish Research Council Research Grants	Supports projects; however once the grants are awarded it is up to the researcher to use the funds in the best way they see fit (does not have to be tied to initial objectives. Researchers will report on progress and performance at next application) Success rate of about 22% Average grant of about $93K p.a., for up to 5 years
Swiss National Science Foundation Investigator-driven Research	Project funding Success rate of about 75% in mathematics, natural and engineering sciences Average grant of about $210K; the great majority of the grants are of less than $200K and the average is influenced by a small number of very large grants (e.g., particle physics at CERN)
Netherlands Organization for Scientific Research Free Competition	Project funding for high risk, innovative research For teams of researchers Researchers can hold multiple grants at a time, although they can only apply for one per competition year Maximum grant of about $640K; grant can be used to purchase equipment costing up to about $177K Success rate in the range of 20-30% depending on the field Free Competition Grants provide funding for the direct costs of research only. Support of graduate students limited to PhD students.
U.S. National Science Foundation	**Individual (and small group) investigator grants**. Funding for projects with short term objectives to be achieved within the projects timeframe. Researchers can hold multiple grants concurrently. Since 2000, average award size $100K - $135K, and average funding rate 24%. Cost of one graduate student: between $40K and 70K (including tuition and overhead) **Career Program:** Provides stable support at a sufficient level and duration to enable awardees to develop careers as outstanding teacher-scholars. Researchers must be employed in a tenure-track position, but not yet tenured. Researcher may receive only one CAREER award in a lifetime. Funded for 5 years at $100K to $125K per year. Success rates 15 – 20 %.