Canada Foundation for Innovation
Fondation canadienne pour l'innovation

# 2009 Report on Results:

## An analysis of investments in research infrastructure

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# Executive Summary

## Introduction

The Canada Foundation for Innovation (CFI) is an independent corporation created by the Government of Canada to fund research infrastructure. The CFI's mandate is to strengthen the capacity of Canadian universities, colleges, research hospitals and non-profit research institutions to carry out world-class research and technology development that benefits Canadians. As of September 23, 2009, the CFI has committed almost $5.2 billion in support of 6,353 projects at 130 research institutions in 65 municipalities across Canada.

**The CFI has committed more than $5.2 billion in support of 6,353 projects.**

## Purpose

By June 30 of each year, institutions funded by the CFI are required to submit Project Progress Reports (PPRs) for each funded project. The purpose of the Project Progress Report is to provide strategically-focused, objective and evidence-based information on outputs and outcomes of CFI-funded infrastructure as they relate to the overall objectives of the CFI.

**The aggregation of project data informs planning and policy.**

The analysis of aggregate data in this report provides valuable information on relevant topics as they pertain to planning and policy by examining:

- societal and economic benefits to Canada;
- strengthening Canada's capacity for innovation;
- levels of attraction and retention of researchers and highly qualified personnel (HQP);
- promotion of productive networks and research collaborations; and
- optimal use of research infrastructure.

## Methodology and sample

The CFI requires PPRs to be submitted for every project for five years following the finalization of an award. As of July 21, 2009, the CFI had received 2,693 of the 2,861 required reports for the 2008-09 reporting period (i.e. 94% submission rate). These constitute the data sample for this analysis. The data included in the Project Progress Reports represent a heterogeneous aggregate sample of projects. Although this data can be practical for measuring the CFI's progress towards achieving its objectives, a number of limitations must be taken into account when interpreting the data, including self-reporting, size and complexity of projects, diversity of projects, timing of project funding, the potential for double counting, and attribution.

**The 2009 Project Progress Reports analysis is based on a submission rate of 94%.**

# Highlights

Key findings from the past year include:

## Research infrastructure leads to social and economic benefits

The availability of the infrastructure led to:

- creation of 4,675 academic, private and public sector jobs;
- development of 1,126 new or improved products, processes or services;
- development of 1,223 best practices in manufacturing organizational structure, healthcare, etc.
- creation of 1,094 environmental benefits;
- creation of 549 new or improved public policies or programs;
- development of 519 invention disclosures, license agreements and IP rights;
- 418 patents filed and 68 granted; and
- creation of 54 CFI-linked spin-off companies.

**Research infrastructure helped create 4,675 academic, private and public sector jobs.**

## Fuelling brain gain

- 79% of project leaders reported that the availability of CFI-funded infrastructure was at least somewhat important in their decision to join the institution;
- 31% of project leaders reported that the availability of infrastructure was an important factor in the decision of researchers to join the institution;
- 14,117 researchers (including the project leader, other principal researchers and other faculty at the institution) advanced their research by using CFI-supported infrastructure;
- Overall, 1,806 new researchers were recruited. Of this number, approximately half (44%) were recruited internationally.

**More than 14,000 researchers advanced their research using CFI-supported infrastructure.**

## Meeting Canada's need for knowledge workers

- 10,361 post-doctoral fellows and graduate students were attracted to the institutions, partly due to the availability of the infrastructure.
- A total of 21,471 post-doctoral fellows and graduate students used the infrastructure as a key resource in their research project.
- A total of 10,492 technical personnel have been trained on the use and maintenance of the research infrastructure.

**More than 21,000 PDFs and GS have used CFI-funded infrastructure as a key resource in their research project.**

## Enhancing Canada's international reputation

**More than 10,500 visiting researchers made use of CFI-funded infrastructure.**

- 10,540 visiting researchers from around the world made use of state-of-the-art infrastructure at Canadian universities, colleges and research hospitals.

## Fostering collaboration

**More than 1,600 formal research collaborations have been reported.**

- Project leaders reported a total of 1,642 formal collaborative research agreements. Of these, 45% were fostered at the local or regional level and 58% were with universities, colleges or hospitals.
- 77% of project leaders said that the availability of CFI-funded infrastructure had enhanced opportunities for informal research collaborations.

# 1.0 Introduction

Created in 1997 as an independent corporation by the Budget Implementation Act 1997, the mission of the Canada Foundation for Innovation (CFI) is to strengthen the capacity of Canadian universities, colleges, research hospitals and non-profit research institutions to carry out world-class research and technology development that benefits Canadians through the provision of research infrastructure. The CFI funds up to 40% of a project's infrastructure costs.[1] The institutions then use this funding to attract the remainder from partners in the public, private and non-profit sectors.

The CFI has committed to supporting several national objectives, including:[2]

- supporting economic growth and job creation as well as health and environmental quality through innovation;
- increasing Canada's capability to carry out important world-class scientific research and technology development;
- expanding research and job opportunities for young Canadians;
- promoting productive networks and collaboration among Canadian post-secondary educational institutions, research hospitals and the private sector.

The Government of Canada's S & T Strategy, *Mobilizing Science and Technology to Canada's Advantage,* identifies and strives to enable three key advantages: an Entrepreneurial Advantage, a Knowledge Advantage, and a People Advantage. In fulfilling its mandate, the CFI not only fosters these key advantages, but also aligns with the four core principles that underlie Canada's S & T Strategy: promoting world-class research excellence, focusing on priorities, fostering partnerships, and enhancing accountability.

The research enabled by the CFI supports the necessary conditions for sustainable, long-term economic growth, including the creation of spin-off ventures and the commercialization of discoveries, which in turn supports improvements to society, quality of life, health, the environment and public policy. As of September 23, 2009, the CFI has committed more than $5.2 billion in support of 6,353 projects at 130 research institutions in 65 municipalities across Canada.

1 Research infrastructure includes the state-of-the-art equipment, buildings, laboratories and databases required to conduct research.
2 Funding Agreement between the Canada Foundation for Innovation and Her Majesty in Right of Canada. March 31, 2007, p. 1

# 2.0 Purpose of the Report

The purpose of the Report on Results is to document the outputs and outcomes of CFI-funded infrastructure as they relate to the overall objectives of the CFI and its programs. The aggregation and analysis of Project Progress Report (PPR) data serves to provide information that informs relevant issues for planning and policy by examining societal and economic benefits to Canada; levels of attraction of researchers and other knowledge workers; progress related to international competitiveness and reputation; and productive networks and research collaborations. In addition, the data presented in this report is used for communicating results to stakeholders and informing future program evaluations and other special studies.

Institutions are asked to provide both quantitative and qualitative data describing activities and outcomes of the past year. PPRs address key areas related to infrastructure and personnel, as well as the research activities enabled by the infrastructure and overall benefits to Canada. It should be noted that the report presents the aggregate results of project funding for the identified sample.

Table 1 offers an overview of the distribution of projects by fund.

**Table 1. Overview of CFI funds reporting in 2009 sample**

| Fund | Number of projects reporting by year | | | | | |
|---|---|---|---|---|---|---|
| | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | TOTAL |
| Leaders Opportunity Fund* | -- | -- | 176 (17%) | 395 (38%) | 466 (45%) | 1,037 (100%) |
| New Opportunities Fund | 340 (41%) | 340 (41%) | 136 (16%) | 13 (2%) | 4 (0.5%) | 833 (100%) |
| Canada Research Chairs | 235 (38%) | 200 (33%) | 120 (20%) | 41 (7%) | 15 (2%) | 611 (100%) |
| Innovation Fund | 56 (46%) | 51 (42%) | 11 (9%) | 2 (2%) | 1 (1%) | 121 (100%) |
| New Initiatives Fund | -- | -- | -- | 21 (70%) | 9 (30%) | 30 (100%) |
| Leading Edge Fund | -- | -- | -- | 20 (69%) | 9 (31%) | 29 (100%) |
| CFI Career Awards | 9 (53%) | 7 (41%) | 1 (6%) | -- | -- | 17 (100%) |
| Research Hospital Fund | -- | 1 (11%) | 7 (78%) | 1 (11%) | -- | 9 (100%) |
| International Access | 3 (100%) | -- | -- | -- | -- | 3 (100%) |
| Exceptional Opportunities | 1 (50%) | -- | -- | 1 (50%) | -- | 2 (100%) |
| National Platforms | -- | -- | -- | 1 (100%) | -- | 1 (100%) |
| Total | 644 (24%) | 599 (22%) | 451 (17%) | 495 (18%) | 504 (19%) | 2,693 (100%) |

* *In 2005-06, the New Opportunities Fund, the CRC Infrastructure Fund and the Career Awards Fund merged into the Leaders Opportunity Fund.*

Additional information and fund descriptions can be found in the CFI Policy and Program Guide at www.innovation.ca.

# 3.0 Methodology

## 3.1 Data collection procedures

Institutions are required to submit a PPR for each funded project by June 30 each year. And PPRs are to be submitted for each project every year for five years following the finalization of the award (i.e. when an award agreement is put in place).

PPR forms and instructions are available on the CFI website by April each year. Individual PPRs are prepared by project leaders and reviewed, assembled and submitted by their host institutions.

The PPR is a self-reported electronic survey with quantitative and qualitative sections. Open-text boxes allow respondents to elaborate on their answers. This offers valuable sources of in-depth information.

## 3.2 Changes to the PPR questionnaire

Significant changes were made to the 2009 PPR questionnaire. While a number of questions were modified or deleted, new questions were also added: Q8 (research funding), Q16 (formal and informal collaborations), Q17 and Q18 (data on research publications and revenue).

Unlike previous reporting years, where projects leaders were asked to provide information for both "the past year" and "since the beginning of the project," all questions in the 2009 questionnaire address a one-year timeframe, from April 1, 2008, to March 31, 2009.[3]

## 3.3 Known data limitations and characteristics

The data included in the PPRs represents a heterogeneous, aggregate sample of projects. Progress report data can be practical for measuring the CFI's advancement toward meeting the objectives set out for the organization. However, there are several considerations to take into account when interpreting the data.

**Self reporting**

Issues of under- and over-reporting are commonly associated with self-reported data. Inaccuracies in reporting can sometimes occur due to a lack of administrative capacity, particularly for large, complex projects.

[3] The exception is Q6, which asks project leaders to provide information from the beginning of the project.

**Size and complexity of projects**

There is great variety in the size and complexity of research infrastructure projects which can affect the speed of implementation and generation of outputs and outcomes. Smaller infrastructure projects, especially those intended to attract and retain researchers, are reasonably easy to plan, finance and develop, whereas large complex awards, such as those funded by the New Initiatives Fund, may take several years to become fully operational.

**Diversity of research projects**

CFI-funded projects span all disciplines and a range of higher education institutions, including universities, colleges, research hospitals and non-profit research organizations. Some projects are also considered basic research while others are applied.

**Timing of project funding and reporting**

The CFI's database for progress reports submitted for the 2008-09 fiscal year contains information on projects that commenced between April 1, 2004, and March 31, 2009. As a result, projects vary in their relative maturity and, therefore, in some of their achieved results.

**Double counting**

The unit of analysis for the PPR is the project (i.e. project leaders are asked to report on each of their individual projects). Although the majority of PPR questions are asked at the project level, some are directed at project leaders, and their research colleagues and trainees. Since it is possible that researchers or trainees work on more than one project at a time, double counting of results may occur.

**Attribution**

The research infrastructure investment made by the CFI is only one facet in a larger research endeavour. Because there are co-funders of the infrastructure, non-infrastructure support of research and training, and many other contributing factors, it can be difficult to precisely attribute impacts.

Despite these limitations, progress reports constitute an important component of the Canadian research scene and represent a unique source of information. It is also worth reiterating that the data include projects that span all disciplines and represents the full range of higher education institutions.

## 3.4 Data sample

By the cut-off date of July 21, 2009, a total of 2,693 of the 2,861 required reports had been received, representing a submission rate of 94%. Table 2 covers reports submitted between April 2008 and March 2009, and the corresponding response rate.

**Table 2. Summary of data sample**

| Category | No. of funded institutions | No. of funded projects | No. of reports submitted | Response rate (%) |
|---|---|---|---|---|
| A. Large universities, hospitals, and non-profit | 38 (42%) | 2,399 (84%) | 2,284 (85%) | 95% |
| B. Small universities | 44 (49%) | 454 (16%) | 406 (15%) | 89% |
| C. Colleges | 8 (9%) | 10 (0.3%) | 3 (0.1%) | 30% |
| Total | 90 (100%) | 2,863 (100%) | 2,693 (100%) | 94% |

Table 2 reflects how the CFI distinguishes between three broad categories of institutions eligible to receive funding. Institutions are categorized based on whether they receive greater than or less than one percent of total federal funding agency awards. Large universities, hospitals and non-profit, therefore, receive greater than one percent of total federal funding agency awards.

### 3.4.1 2009 sample profile

**Composition of 2009 sample by fund and project**

The 2009 sample consists of data for 13 fund categories. Projects classified under the Leaders Opportunities Fund represent 39% of the sample, followed by the New Opportunities Fund (31%) and the Canada Research Chairs (23%). See Figure 1.[4]

[4] Funds representing less than one percent of the total sample have been included in the 'other' category. They include the New Initiatives Fund (1%), the Leading Edge Fund (1%), the CFI Career Awards (0.6%), the Research Hospital Fund (0.3%), the International Access Fund (0.1%), the Exceptional Opportunities Fund (0.07%) and the National Platforms Fund (0.04%).

**Figure 1. Composition of sample by fund (n=2,693)**

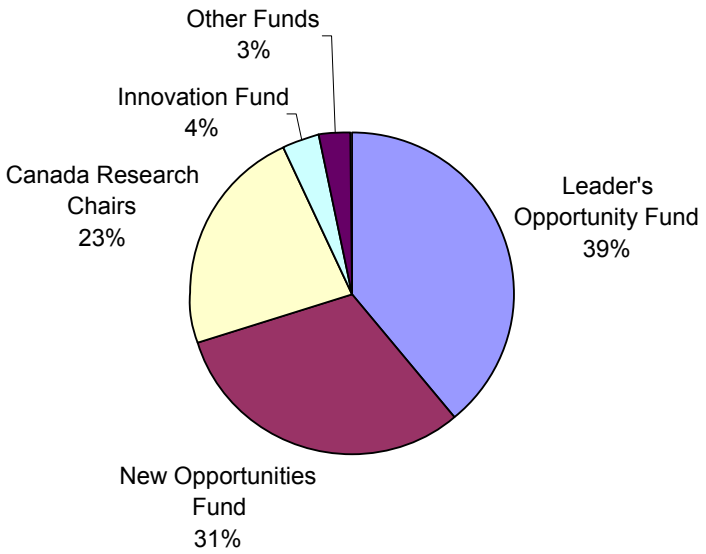



Table 3 summarizes the dollar value of the 2009 sample. The total projects in the sample represent a CFI investment of $1.2 billion. The majority of these projects (72% or 1,936 projects) received awards of less than $200,000. Only 5.6% of the projects in the sample received awards of $1 million or more.

**Table 3. CFI awarded amounts by range**

| Ranges of awarded amounts ($) | No. of projects | CFI $ amount |
|---|---|---|
| < 200K | 1,936 (72%) | $220,683,131 |
| 200K to < 1M | 605 (23%) | $189, 865, 775 |
| 1M to < 4M | 76 (3%) | $176,008,328 |
| 4M to < 10M | 61(2%) | $379,584,134 |
| 10M to < 20M | 13 (0.5%) | $185,795,767 |
| ≥ 20M | 2 (0.1%) | $72,400,256 |
| Total | 2,693 (100%) | $1,224,337,391 |

### Projects by sector

Table 4 shows the 2009 sample segmented by sector. It should be noted that project leaders identify the sector. Selections are not validated by the CFI. The Government of Canada's S & T Strategy, *Mobilizing Science and Technology to Canada's Advantage*, identifies four priority research areas.

1. Natural resources and energy
2. Information and communications technology
3. Health and related life sciences and technologies
4. Environmental S & T

The data in Table 4 reveals that CFI project funding is aligned with the government's priority areas.

**Table 4. Project by sector**

| Sector | No. of projects | % |
|---|---|---|
| Health | 1,133 | 42% |
| Science | 547 | 20% |
| Engineering | 532 | 20% |
| Environment | 265 | 10% |
| Social sciences | 216 | 8% |
| Total | 2,693 | 100% |

### Implementation status and project maturity

A key consideration with respect to the 2009 sample is the implementation status of the infrastructure and the relative maturity of the individual projects. As would be expected, the older the project, the more likely it is that the infrastructure has been fully acquired/developed, operational and used for research.

Figure 2 reveals the operational status of the infrastructure. These data show that 91% of the projects included in the 2009 sample were either partially or fully developed and were utilized for research for at least part of the year.

**Figure 2. Operational status of infrastructure (n=2,693)**

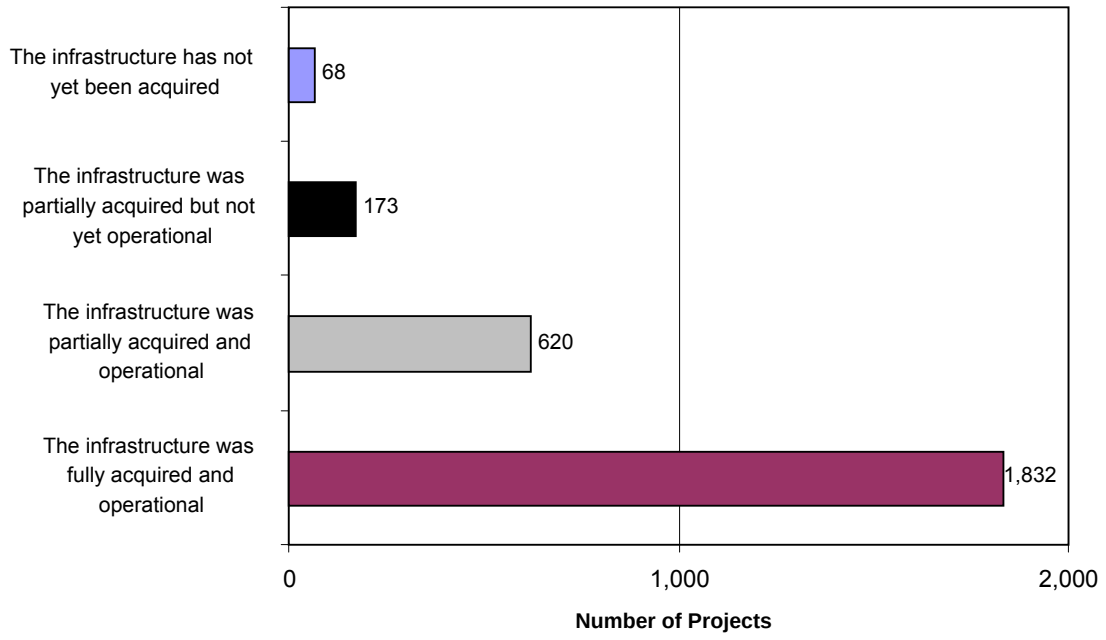



Table 5 shows the number of projects by year included in the 2009 sample and presents their level of operational status as identified by the institution.

**Table 5. Project maturity by fiscal year (n = 2,693)**

| Fiscal year | No. of years since award finalization | Total No. of projects | Fully operational | Partially operational | Not sufficiently developed |
|---|---|---|---|---|---|
| April 2008 to March 2009 | 1 | 504 | 130 (26%) | 206 (41%) | 168 (33%) |
| April 2007 to March 2008 | 2 | 495 | 254 (51%) | 201 (41%) | 40 (8%) |
| April 2006 to March 2007 | 3 | 451 | 343 (76%) | 94 (21%) | 14 (3%) |
| April 2005 to March 2006 | 4 | 599 | 527 (88%) | 60 (10%) | 12 (2%) |
| April 2004 to March 2005 | 5 | 644 | 578 (90%) | 59 (9%) | 7 (1%) |

These data are important to consider because research and innovation projects generally require a considerable period of time to demonstrate results. For example, projects less than two years old typically generate fewer, if any, measurable outcomes because they are acquiring infrastructure, building or renovating research facilities, etc.

# 4.0 Results

The Federal Government's S & T Strategy aims to build an S & T advantage for Canada based on three priority areas, including an Entrepreneurial Advantage, a Knowledge Advantage, and a People Advantage. The CFI plays a significant role in supporting the national strategy, aiming to:

- supporting economic growth and job creation as well as health and environmental quality through innovation;
- increasing Canada's capability to carry out important world-class scientific research and technology development;
- expanding research and job opportunities for young Canadians;
- promoting productive networks and collaboration among Canadian post-secondary educational institutions, research hospitals and the private sector.

This section addresses the key outputs and outcomes of CFI-supported infrastructure by summarizing the information obtained from the institutions in the 2009 PPRs.

## 4.1 Benefits to Canada

**Key findings — Benefits to Canada**

The availability of the CFI-funded infrastructure has led to the creation of:

- ✓ 4,675 academic, private and public sector jobs;
- ✓ 1,126 new or improved products, processes or services;
- ✓ 1,094 environmental benefits;
- ✓ 1,005 invention disclosures, patents, license agreements or other IP rights;
- ✓ 418 patents filed and 68 patents granted;
- ✓ 54 CFI-linked spin-off companies.

CFI investments in infrastructure have helped generate a variety of social or economic benefits to Canada. Table 6 presents an overview of how societal and economic benefits may be generated directly by the activities of researchers and trainees, or indirectly by other users of the research infrastructure.

| Table 6. Benefits to Canada (n=2,452) | | | |
|---|---|---|---|
| | **No. of project leaders responding 'yes'** | **How many?** | **What types?** |
| Jobs created in the academic/hospital sector | 762 (31%) | 3,502 | Examples include:<br>- laboratory management positions;<br>- research assistant positions;<br>- laboratory technicians;<br>- administrative positions.<br>The majority of academic/hospital sector jobs were created in the natural sciences/engineering and health sciences sectors. |
| Jobs created in the private sector | 166 (7%) | 625 | Examples include:<br>- research consultants;<br>- instrumentations technicians;<br>- engineers.<br>The majority of private sector jobs were created in the natural sciences/engineering and health sciences sectors. |
| Jobs created in the public/non-profit sector | 109 (4%) | 548 | Examples include:<br>- research assistant/consultants;<br>- technologists;<br>- administrative assistants.<br>The majority public/non-profit sector jobs created were reported to be in the natural sciences/engineering and health sciences sectors. |
| New or improved products, processes, or services | 500 (20%) | 1,126 | Examples include:<br>- improved techniques for sequencing plasmids;<br>- pulp/paper wastewater treatment technology;<br>- improved methods of crop control;<br>- electronic multimedia educational tools. |
| Environmental benefits | 408 (17%) | 1,094 | Examples include:<br>- improvements to fuel cell production processes;<br>- lightweight automobile components for improved vehicle efficiency;<br>- improved ecosystem monitoring via development of invertebrate skeletons. |
| Improved health care protocols, processes or services including cost savings, etc. | 379 (15%) | 688 | Examples include:<br>- tests for establishing mental competence in dementia patients;<br>- research advancements in the study of developmental diseases, multiple sclerosis, cancer and aging;<br>- improved treatments for post-stroke recovery and spinal cord injured patients. |
| New or improved public policies and programs | 319 (13%) | 549 | Examples include:<br>- drinking water regulations;<br>- protocols for determining the environmental impact of marine life;<br>- policy contributions regarding immunization pain management;<br>- policy contributions regarding trans fat content in foods;<br>- programs/policies encouraging physical activity in schools. |
| Best practices in manufacturing, organizational structure, healthcare, etc. | 143 (6%) | 1,223 | Examples include:<br>- professional development;<br>- best management practices in livestock production<br>- best practices for front-line workers dealing with child witnesses;<br>- development of intelligent diagnostic and prognostic techniques/tools for use in manufacturing. |
| Other benefits | 710 (29%) | 2,136 | Examples include:<br>- increased international competitiveness;<br>- public outreach activities;<br>- training of HQP;<br>- improved training and/or working environments for students, technicians, and teaching staff. |

* Please note percentages exceed 100% as a result of multiple responses.

Additional benefits to Canada include the creation of patents and spin-off companies, as well as the development of invention disclosures, licensing agreements and other IP rights. Table 7 offers an overview of these types of benefits.

**Table 7. Patents, licenses and spin-off companies (n=2,452)**

| | No. of project leaders responding 'yes' | % Yes* | If yes, how many? |
|---|---|---|---|
| Patents filed | 224 | 9% | 418 |
| Invention disclosures | 162 | 7% | 328 |
| Spin-offs | 48 | 2% | 54 |
| Patents granted | 42 | 2% | 68 |
| Licensing agreements | 37 | 2% | 71 |
| Other IP rights** | 23 | 1% | 78 |
| Other*** | 19 | 1% | 42 |

* Please note percentages do not total 100% as a result of multiple responses.
** Other IP rights include copyrights, plant breeder's rights, industrial design, etc.
*** Other responses include copyright applications in progress and invention disclosures.

## 4.2 Strengthening Canada's capacity for innovation

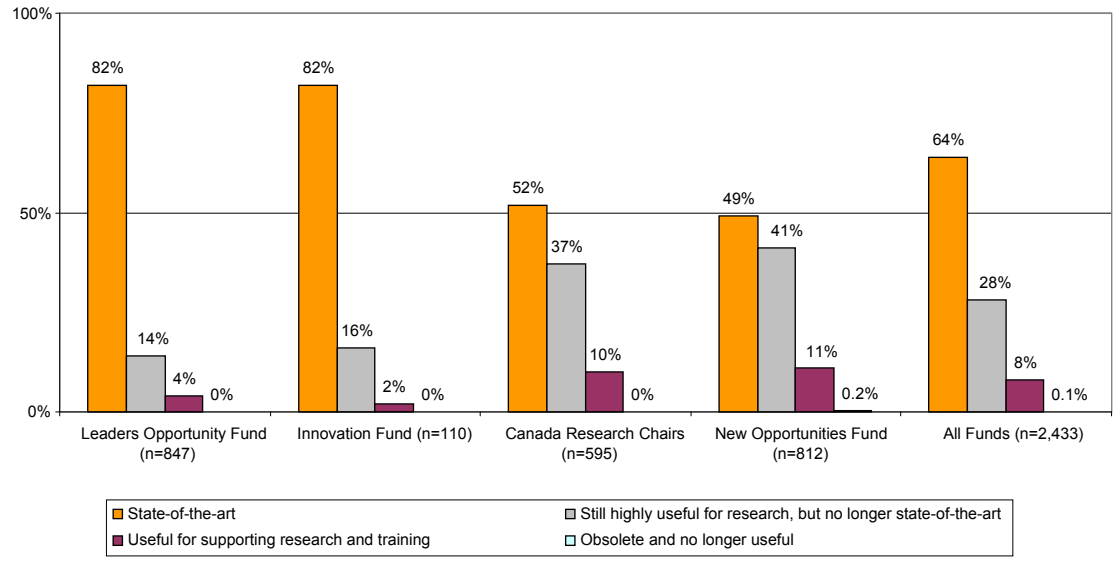
### Key findings — strengthening Canada's capacity for innovation

- ✓ Overall, 64% of project leaders said that their infrastructure is state-of-the-art; 28% of project leaders reported that their infrastructure is still highly useful for research.
- ✓ On average, the useful remaining life across all infrastructure types is 8.6 years. Useful life remaining ranges from a low of four years (computing equipment, software, etc.) to a high of 14 years (for buildings and research facility space).

**Comparative quality of CFI-supported infrastructure**

Figure 3 shows the comparative quality of CFI-funded infrastructure that was operational during the past year as assessed by project leaders.

**Figure 3. Comparative quality of operational infrastructure**




*Note: Percentages in Figure 3 were calculated excluding "not applicable" responses (n=19).*

Overall, 64% of project leaders rated the quality of the CFI-funded infrastructure as state-of-the-art. An examination of the funds revealed that:

- *Leaders Opportunity Fund*: 82% of project leaders reported that their infrastructure is state-of-the-art; 14% said their infrastructure is still highly useful for research;

- *Innovation Fund*: 82% of project leaders reported that their infrastructure is state-of-the-art; 16% said their infrastructure is still highly useful for research;
- *Canada Research Chairs Infrastructure Fund:* 52% of project leaders reported that their infrastructure is state-of-the-art; 37% said that their infrastructure is still highly useful for research; and
- *New Opportunities Fund*: 49% of project leaders reported that their infrastructure is state-of-the-art; 41% said that their infrastructure is still highly useful for research.

**Useful remaining life of CFI-supported infrastructure**

Useful life can be defined as the length of time that a depreciable asset is expected to be usable. The lifespan of the asset however, is directly dependent on the application. Computer servers, software and databases have on average the lowest useful life at approximately four years. At the other end of the spectrum, building(s) and research facility space have an average useful life of 14 years. Table 8 shows that the average remaining useful life across all types of infrastructure is 8.6 years.

**Table 8. Useful remaining life of infrastructure (n=2,452)**

| Infrastructure types | Average years of useful life remaining* |
|---|---|
| Building(s) and research facility space | 14.0 |
| Non-specialized or standard research equipment | 7.7 |
| Highly-specialized research equipment, as appropriate to your field | 7.2 |
| Computing workstations, servers, software, databases, etc. | 3.7 |
| Other (e.g. field vehicles/equipment, clean rooms) | 10.5 |
| Average across all infrastructure types | 8.6 |

* *Simple average*

## 4.3 Attraction, retention, and training of research personnel

### Key findings — attraction, retention and training of research personnel

- ✓ Researchers
  79% of project leaders report that the availability of the infrastructure was at least somewhat important in their decision to join an institution.
  - Overall, 1,806 new researchers were recruited. Of these, 20% were recruited from the U.S. and 24% were recruited from elsewhere. The top five "other countries" identified were France, U.K., China, Japan and South Korea.
  - Of the 1,806 researches recruited, 87% were recruited from the academic/ hospital sector.

- ✓ Post-doctoral fellows (PDF) and graduate students (GS)
  10,361 PDF/GS were attracted to the institutions due to the availability of the infrastructure.
  - Project leaders reported that more than 21,471 PDF and GS have used the infrastructure as a key resource in their research project. Of this group, 76% have remained at the institution as trainees.

- ✓ Technical personnel
  - 90% of project leaders said that the quality of the CFI-infrastructure was either world-class or excellent for training purposes.
  - A total of 10,492 technical personnel have been trained on the use and maintenance of the infrastructure since the beginning of their projects. Of this group, 67% have stayed at the institution while an additional 10% have joined another Canadian academic institution, college or research hospital.

### 4.3.1 Researchers

**Number and origin of project leaders attracted to the institutions**

One of the CFI's key objectives is to expand research and job opportunities by providing support through research infrastructure for the development of highly qualified personnel (HQP). A total of 504 project leaders in the 2009 sample were reporting for their first year. Of these:[5]

- 400 project leaders (79%) reported that the infrastructure was at least somewhat important in their decision to join the institution;
- 272 project leaders (54%) reported that they were recruited from Canada; and
- more than half (54%) of project leaders recruited from other countries were repatriated Canadians.

[5] This question was asked of project leaders reporting in their first year only.

**Number and origin of researchers attracted to the institutions**

Thirty-one percent (or 845) of project leaders reported that the infrastructure was an important factor in the decision of a researcher to join the institution. Table 9 summarizes the number of researchers recruited by fund and country of origin. Overall, project leaders reported a total of 1,806 researchers were recruited. Of these:

- 1,004 researchers (56%) were recruited from within Canada;
- 367 researchers (20%) were recruited from the U.S.;
- 435 researchers (24%) were recruited from other countries;
- 33% of researchers recruited from other countries (including the U.S.) were repatriated Canadians.

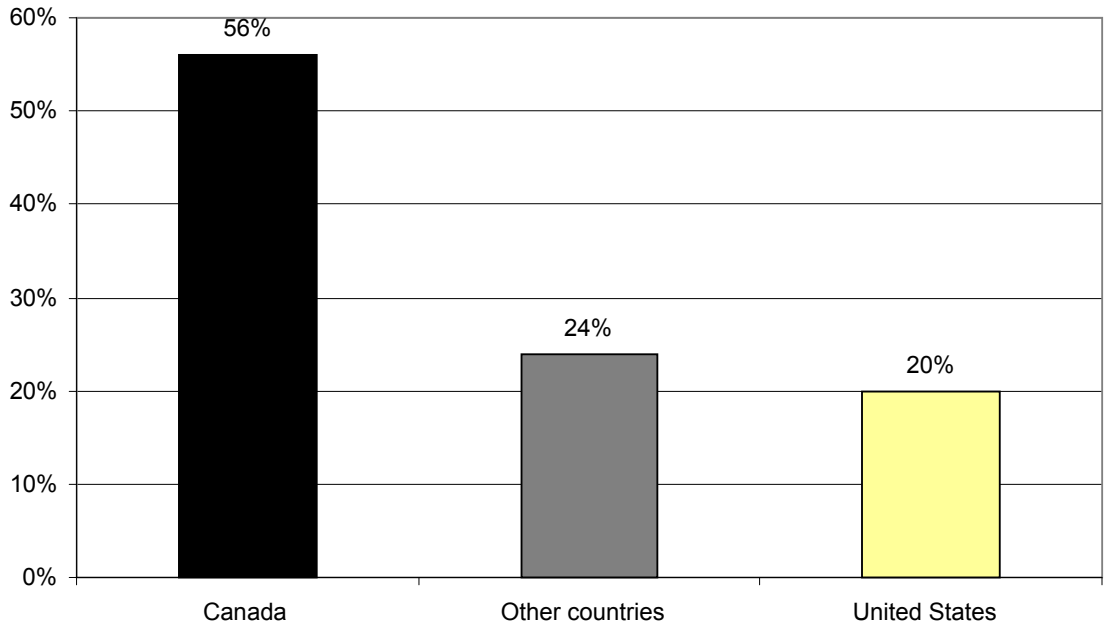
**Table 9. Number of researchers recruited by fund and country of origin**

| Fund | No. of Projects | No. of Researchers Recruited | No. Recruited from Canada | No. Recruited from U.S. | No. Recruited from Other Countries* | No. of Repatriated Canadians |
|---|---|---|---|---|---|---|
| Leaders Opportunity Fund | 1,037 | 591 | 309 | 142 | 140 | 93 |
| New Opportunities Fund | 833 | 392 | 206 | 72 | 114 | 54 |
| Canada Research Chairs Infrastructure Fund | 611 | 462 | 261 | 72 | 129 | 60 |
| Innovation Fund | 121 | 232 | 162 | 46 | 24 | 30 |
| New Initiatives Fund | 30 | 40 | 20 | 13 | 7 | 8 |
| Leading Edge Fund | 29 | 61 | 32 | 13 | 16 | 14 |
| CFI Career Awards | 17 | 7 | 3 | 2 | 2 | 1 |
| Research Hospital Fund | 9 | 14 | 8 | 4 | 2 | 3 |
| International Access Fund | 3 | -- | -- | -- | -- | -- |
| Exceptional Opportunities Fund | 2 | 7 | 3 | 3 | 1 | 1 |
| National Platforms | 1 | -- | -- | -- | -- | -- |
| Total | 2,693 | 1,806 | 1,004 | 367 | 435 | 264 |

***** Other countries commonly identified by project leaders include the U.K., China, France, Japan and South Korea.

Figure 4 demonstrates the origin of researchers recruited in the past year.

**Figure 4. Origin of researchers recruited**




**Sector of origin of researchers**

Data from the Project Progress Reports show that researchers are recruited from a variety of sources. More specifically, of the 1,806 researchers recruited:

- 1,564 (87%) were recruited from the academic/hospital sector;
- 121 (7%) were recruited from the public/non-profit sectors;
- 120 (7%) were recruited from the private sector.

## 4.3.2 Post-doctoral fellows and graduate students[6]

**Importance of infrastructure for PDFs and graduate students**

A total of 2,134 project leaders said that the availability of the CFI-funded infrastructure was an important factor for 10,361 PDF and GS in their decision to join the institution. Table 10 summarizes the number of students for whom the availability of CFI-funded infrastructure was an important factor in their decision to join an institution, as well as where their origin.

[6] Please note that this section was completed for funded projects from universities and research hospitals only.

**Table 10. No. PDF and GS recruited, by origin (n=2,134)**

| | No. of Projects* | No. of PDFs Recruited | No. of PhDs Recruited | No. of Masters Recruited | Total No. of Students Attracted |
|---|---|---|---|---|---|
| From within the institution | 2,088 | 591 (13%) | 1,429 (32%) | 2,519 (55%) | 4,539 (100%) |
| From another Canadian institution | 1,601 | 597 (22%) | 793 (29%) | 1,327 (49%) | 2,717 (100%) |
| From another foreign institution | 1,564 | 965 (37%) | 928 (35%) | 738 (28%) | 2,631 (100%) |
| From a U.S. institution | 391 | 234 (49%) | 135 (28%) | 105 (22%) | 474 (100%) |
| | Total | 2,387 (23%) | 3,285 (32%) | 4,689 (45%) | 10,361 (100%) |

* Project totals exceed 2,134 as a result of multiple responses.

**Career paths of PDF and GS**

Many project leaders track the career paths of the students who have worked in their labs. A total of 21,471 PDF and GS have used the infrastructure as a key resource in their research project.

Of those who continue with their training:

- 16,228 (76%) have stayed at the institution as trainees;
- 1,200 (6%) have joined another Canadian academic institution, college or research hospital as a trainee.

Of those who stopped their training:

- 1,348 (6%) have left training to take jobs in the private, public or not-for-profit sector;
- 741 (3%) have joined another Canadian academic institution, college or research hospital as employees or contractors;
- 995 (5%) have moved abroad;
- 615 (3%) have stayed at the institution as an employee or contractor.

**Career paths of undergraduate students**

Project leaders also track the career paths of their undergraduate students. A total of 7,080 undergraduates have used the infrastructure as a key resource in their research projects.

Of those who continue with their training:

- 4,820 (68%) have remained at the institution as a trainee;
- 832 (12%) have joined another Canadian academic institution, college or research hospital as a trainee.

Of those who stopped their training:

- 427 (6%) have taken jobs in the private, public or not-for-profit sector;
- 398 (6%) have joined another Canadian academic institution, college or research hospital as employees or contractors;
- 209 (3%) stayed at the institution as an employee or contractor;
- 199 (3%) have moved abroad.

**Impact of CFI-funded infrastructure on the recruitment and retention of researchers, enrichment of the training environment and employment of trainees( n=1,000)**

More than 1,900 project leaders commented on the impact of the CFI-funded infrastructure on the recruitment and retention of researchers, enrichment of the training environment and employment of trainees.[7] The following analysis is based on the examination of 1,000 project leader comments.

The comments reflect the positive impact of CFI investments have in attracting researchers. The majority of project leaders believe CFI-funded infrastructure has an impact on the recruitment and retention of HQP as well as on the training of students at all university levels. For example:

> *This is a difficult question to answer precisely. We know how the CFI infrastructure has been used for the training and career development of personnel at our Centre but cannot definitively express the impact of the infrastructure in the training in the laboratories of our hundreds of research clients. Judging from visits, internships, teleconferences, thesis reviews, and manuscript submissions, we firmly believe that the CFI equipment being used in projects is positively affecting the career development of many students and trainees.* **McGill University**

Six key themes on the significance of CFI-funded infrastructure on recruitment, retention and training emerged from the analysis of 1,000 comments.

### 1. Key contributing factor for recruitment

Most project leaders see CFI investment as positive or even crucial in attracting researchers. Some respondents describe CFI investments as "essential" or "absolutely critical," while others report that CFI-funded infrastructure makes recruitment and retention possible.

Some project leaders noted that CFI-funded infrastructure helps attract talent since it is an important element in making research appealing to new recruits. Many comments credit CFI investments with improving the recruitment of international researchers, faculty and students by making labs more technologically attractive.

**"By giving lab capabilities that didn't exist before, the infrastructure is highly influential in recruiting new faculty and trainees."** **Queen's University**

### 2. Encourages research hubs

The concentrated location and composition of CFI-funded research facilities has a positive impact on recruitment. CFI investments have enabled the development of centralized facilities that greatly enhance the research environment at different levels and this, in turn, contributes to attracting recruits.

**"High performance state-of-the-art equipment attracts a wide range of users and a rich multidisciplinary training environment."** **University of British Columbia**

[7] PPR 2009, Question 7: "Taking into account your answers to questions 2 through 6, please provide further comment in the box below on the impact of the CFI-funded infrastructure project on the recruitment and retention of researchers, enrichment of the training environment and employment of trainees."

### 3. Indirect impacts on recruitment, retention and training

The impact of CFI-funded infrastructure on attracting and retaining talent is not always straight forward. Some of the more indirect effects are categorized as follows:

#### Attracting recruits through increased visibility

Large CFI investments in areas of critical current interest attract the attention of research talent in Canada and abroad. State-of-the-art facilities with equipment being used by world-class research for cutting-edge research generate considerable interest from principal investigators and HQP from around the world. Such increased visibility attracts world-class talent and trainees.

**"Because of this infrastructure we have a lot of visibility here and abroad which attracted excellent candidates."** **École Polytechnique de Montréal**

#### Enabling high-quality research with modern equipment

Researchers require modern labs and rely on sophisticated equipment to conduct their experiments. The CFI enables research to levels where the output is significantly increased. These labs are magnets for attracting and retaining talented staff.

#### Promoting research multidisciplinarity and networks

The concentrated location and composition of CFI-funded infrastructure enables and empowers research networks and research communities, and has a strong influence in fostering multidisciplinarity — an important component of research that has relevance for graduate training. There is evidence of the many benefits of research networks in increasing multidisciplinarity, collaborations, recruitment, retention and training.

**"It helps to create community which is a very important component of graduate student experience."** **University of Ottawa**

### 4. Attraction and training of undergraduate students

CFI-funded infrastructure has positive impacts on the attraction and training of undergraduate students. National and international undergraduate students are attracted to an institution, at least in part, by the available research equipment. Several positive comments reinforce the training opportunities for undergraduates using the CFI-funded infrastructure and the unique experience this represents.

**"…plays a pivotal role in attracting undergraduate students to perform research."** **Mount Saint Vincent University**

### 5. Type of science/discipline

Depending on the nature of research, the impact of CFI funding on recruitment and retention varies. Each research project has particular characteristics that can make attraction and retention either more or less challenging. For projects in a scientific area with few other research centres conducting the same research, staff turnover is expectedly low. But for research projects in areas of science with presence at multiple research centres, staff turnover is higher, and retention and recruitment is more challenging.

**"The CFI funded lab remains the only one of its kind in Canada, and one of a handful in the world…over the past two years a source of attraction for graduate students and postdoctoral researchers."** **Université de Montréal**

**6. Recession and political context**

Budget cuts and limited access to resources have had a negative impact on the retention of researchers and in the attraction of new ones. It is anticipated that recent increases in scientific funding in the United States will increase opportunities south of the border and impact the flux of researchers coming to Canada.

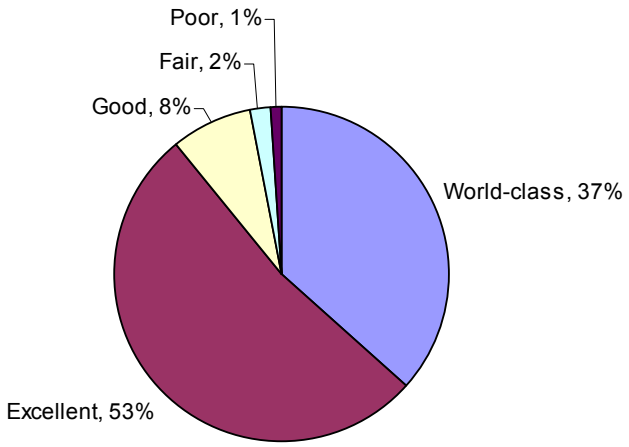
**"The recent economic recession is not reflected by our current trainee numbers, but recruitment is going to diminish, at least over the short term."**
**University of British Columbia**

## 4.3.3 Technical personnel

### Quality of infrastructure for training purposes

Figure 5 summarizes the quality of CFI-funded infrastructure for training purposes. As demonstrated, virtually all (90%) project leaders said that the quality of CFI-funded infrastructure was either world-class or excellent.

**Figure 5. Quality of infrastructure for training purposes (n=2,546)***




*Percentages have been adjusted to exclude "not applicable" responses.

**Training**

A variety of technical personnel are also being trained as a result of infrastructure investments. Since the *beginning of the project*, project leaders report that 10,492 technical personnel have been trained on the use and maintenance of research infrastructure. Of these:

- 6,990 (67%) have stayed at the institution;
- 1,032 (10%) have joined another Canadian academic institution, college or research hospital;
- 704 (7%) have joined the Canadian private business sector;
- 539 (5%) have moved abroad;
- 293 (3%) have joined the Canadian public sector;
- 64 (0.6%) have joined the Canadian non-profit sector; and
- 870 (8%) have been classified as "other."[8]

### 4.3.4 Research funding

Table 11 summarizes the impact of CFI-funded infrastructure on the ability of project leaders to attract additional research funding from a variety of sources. There has been more than $3 billion dollars in "new funding" attracted. The majority of funding has come from four sources: federal government (59%); provincial government (37%); trust funds, foundations and institutions (36%); corporations and firms (29%).

[8] Responses classified as "other" vary and are too broad to quantify. They range from returning to school to maternity leave to retiring. They also represent a small proportion of the overall number reported. A significant number of respondents said they did not know where the technical personnel went once they left the institution.

| Table 11. Attraction of additional research funding (n=2,693) | | | | |
|---|---|---|---|---|
| | **Major impact** | **Minor impact** | **No impact** | **Total value of new funding** |
| Federal government (departments or agencies) | 1,285 (48%) | 295 (11%) | 1,113 (41%) | $1,150,633,956 |
| Provincial government (departments or agencies) | 779 (29%) | 223 (8%) | 1,691 (63%) | $922,809,247 |
| Corporations / firms | 552 (21%) | 218 (8%) | 1,923 (71%) | $195,604,020 |
| Institutions, trust funds and foundations | 292 (11%) | 685 (25%) | 1,716 (64%) | $734,930,100 |
| Other governmental sources (municipal or foreign) | 185 (7%) | 113 (4%) | 2,395 (89%) | $71,208,859 |
| Voluntary organizations / firms | 114 (4%) | 92 (3%) | 2,487 (92%) | $19,792,675 |
| Other (private donations, in-kind contributions, etc.) | 137 (5%) | 53 (2%) | 2,503 (93%) | $396,837,158 |
| | | | Total | $3,491,816,015 |

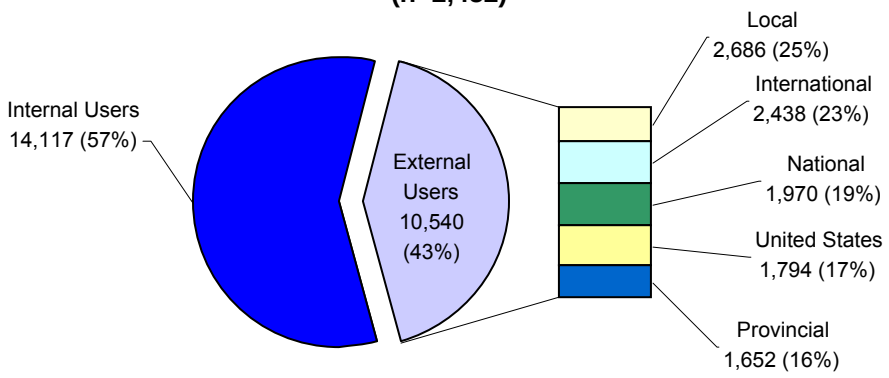
## 4.4 Promoting networking and collaboration

### Key findings — networking and collaboration among researchers

- ✓ More than 24,000 researchers (14,117 internal and 10,540 external) advanced their research by using infrastructure supported by the CFI.
- ✓ The vast majority (86%) of researchers advancing their research on CFI projects do so at large universities, hospitals and non-profits.
- ✓ Project leaders reported a total of 1,642 formal collaborative research agreements. Of these, 45% were fostered at the local or regional level and 58% were with universities, colleges or hospitals.

Project leaders reported that 24,657 internal and external researchers advanced their research by using infrastructure supported by the CFI (Figure 9). This number is based on 2,452 projects that were fully or partially operational and used for research during the past year.

**Figure 6 - Users of the research infrastructure (n=2,452)**




Based on the 10,540 external users of the research infrastructure, approximately 40% represent international users (i.e. international and U.S.). The highest proportion of reported external users is at the local level, at 25%. The top five “other countries” identified include the U.K., France, Germany, Australia and China.

The majority (83%) of users are from the university, college and hospital sector followed by public sector (10%) and private sector (6%) users.

**Number of researchers advancing research by using CFI-supported infrastructure**

A total of 14,117 internal researchers (including primary researchers, other principal researchers and other faculty) advanced their research by using CFI-supported infrastructure. Table 12 shows the number of researchers advancing their research broken down by fund and category of institution. The vast majority (86%) of researchers advancing their research (at the institution) using CFI-funded infrastructure do so at large universities, hospitals and non-profit organizations.

**Table 12. Number of researchers advancing research by fund and category of institution**

| Fund | No. of projects | No. of researchers | | | | TOTAL /Project |
|---|---|---|---|---|---|---|
| | | Large universities, hospitals and non-profit | Small universities | Colleges | TOTAL | |
| Leaders Opportunity Fund | 856 | 3,188 | 517 | -- | 3,705 | 4.33 |
| New Opportunities Fund | 816 | 2,806 | 484 | -- | 3,290 | 4.03 |
| Canada Research Chairs | 599 | 2,632 | 431 | -- | 3,063 | 5.11 |
| Innovation Fund | 111 | 2,113 | 414 | 19 | 2,546 | 22.94 |
| Leading Edge Fund | 26 | 689 | 43 | -- | 732 | 28.15 |
| New Initiatives Fund | 17 | 203 | 14 | -- | 217 | 12.76 |
| CFI Career awards | 14 | 153 | -- | -- | 153 | 10.93 |
| Research Hospital Fund | 8 | 254 | -- | -- | 254 | 31.75 |
| International Access Fund | 3 | 6 | -- | -- | 6 | 2.00 |
| Exceptional Opportunities | 2 | 84 | -- | -- | 84 | 42.00 |
| National Platforms Fund | 1 | 67 | -- | -- | 67 | 67.00 |
| Total | 2,452 | 12,195 | 1,903 | 19 | 14,117 | 5.76 |

**Formal research collaborations**

A total of 666 project leaders said they had signed or entered into 1,642 formal collaborative research agreements. Table 13a summarizes the number of formal agreements by geographic region. Table 13b shows the number of formal agreements by sector of origin.

**Table 13a. Number of formal collaborative agreements, by geographic region**

| Geographic region | No. of projects* | No. of formal agreements |
|---|---|---|
| In other countries | 188 | 268 (16%) |
| In the United States | 201 | 275 (17%) |
| Elsewhere within Canada | 216 | 367 (22%) |
| Elsewhere within the province | 185 | 276 (17%) |
| Local level | 267 | 456 (28%) |
| | Total | 1,642 (100%) |

***** Number of projects exceeds 666 as a result of multiple responses.

**Table 13b. Number of formal collaborative agreements, by sector of origin**

| Sector | No. of projects* | No. of formal agreements |
|---|---|---|
| Universities, colleges or hospitals | 448 | 957 (58%) |
| Private sector | 229 | 389 (24%) |
| Public/non-profit sector | 181 | 296 (18%) |
| | Total | 1,642 (100%) |

***** Number of projects exceeds 666 as a result of multiple responses.

### Informal research collaborations

Seventy-seven percent of project leaders said the availability of CFI-funded infrastructure offered enhanced opportunities for informal research collaborations.

**The impact of CFI-funded infrastructure on opportunities for informal research collaborations (n=343)**

A total of 1,906 project leaders commented on the impact of CFI-funded infrastructure on opportunities for informal research collaborations.[9] The following analysis is based on the examination of 343 project leader comments.

Three themes emerged from the analysis of 343 project leader comments. Their comments suggest that they recognize the importance of collaborative work and actively seek to partner with other researchers or with industry, both within Canada and abroad.

### Fostering informal collaborations

Informal research collaborations are developed in a number of different ways. Key types of informal collaborations identified by project leaders include: informal consultations/discussions, sharing of research facilities and infrastructure, knowledge sharing, as well as participating in site visits and conferences. Project leaders widely credit CFI investments for allowing them to build a reputation as a leader within their field.

#### 1. Informal collaborations with academic researchers within Canada

The most common type of informal collaboration identified by project leaders was with academic researchers within Canada. This included both informal collaborations within institutions (i.e. with researchers in other departments) and with other university researchers in Canada.

**"The availability of this instrument has allowed us to work with researchers in other departments. Some of these collaborations have formed the basis of manuscripts now in progress…"** **University of Alberta**

#### 2. Informal collaborations with academic researchers in other countries

More than a quarter of project leaders reported that the availability of CFI-funded infrastructure had enhanced opportunities for informal collaborations with academic researchers outside of the country. Informal research collaborations are taking place in both industrialized nations (e.g. U.S., U.K., European Union and Japan), as well as in other parts of the world such as Brazil, China, Korea and India.

#### 3. Informal collaborations with the private sector

A smaller number of project leaders indicated that the availability of CFI-funded infrastructure had enhanced opportunities for informal collaborations with the private sector. That said, a large number of project leaders expressed interest in building collaborations with the private sector in the future or noted the importance of industry partnership in strengthening their research and cost sharing.

Examples of industry collaborations include partnerships with local industry (e.g. SMEs) and larger international corporations (e.g. IBM, Intel Corporation, Bombardier, United Microwave Corporation, etc.).

**"We have started discussions with about a half dozen private sector partners on joint collaborative projects, but it is too early to say whether these will all come to fruition."** **University of British Columbia**

[9] PPR 2009, Question 16ii: "In the past year, has the availability of CFI-funded infrastructure enhanced opportunities for informal research collaborations?"

## 4.5 Research publications

### Key finding — research publications

✓ 89% of project leaders indicated that there were peer-reviewed publications or other research outputs (e.g. presentations at conferences, books, etc.) related to CFI-funded infrastructure.

In the past year, 89% of project leaders indicated that there were 34,457 peer-reviewed publications or other research outputs (e.g. presentations at conferences, books, etc.) related to the CFI-funded infrastructure. Of these:

- 16,768 (49%) were presentations at conferences;
- 14,904 (43%) were peer-reviewed publications;
- 485 (1%) were books; and
- 2,300 (7%) were other research outputs, including book chapters, television and radio interviews, academic lectures and workshops.

## 4.6 Revenue derived from end users

### Key finding — revenue

✓ The total amount of revenue-derived from end users related to CFI-funded infrastructure is $79,382,787.

Table 14 outlines the source and total amount of revenue derived from end users related to CFI-funded infrastructure.[10] Only 11% (272) of project leaders reported that there had been revenue derived from end users related to CFI-funded infrastructure.

[10] End-users are defined as individuals or organizations outside the academic community (typically in industry or government) who use the research results to develop practical applications.

| Table 14. Attraction of new funding | | |
|---|---|---|
| | **No. of projects*** | **Amount of revenue** |
| Fees for service activities | 169 | $40,431,724 |
| Contract research projects that use CFI-funded infrastructure | 121 | $13,914,713 |
| Collaborative research projects, consortia, etc., that use CFI-funded infrastructure | 101 | $19,198,992 |
| Other** | 37 | $5,837,358 |
| | Total amount of revenue generated | $79,382,787 |

* Number of projects exceeds 272 as a result of multiple responses.
** Examples of other sources of funding include revenue from private sector and industry partners.

## 4.7 Optimal use of research infrastructure

### Key findings — optimal use of research infrastructure

- ✓ 75% of project leaders reported that the infrastructure was fully utilized and 9% reported that it was over subscribed.
- ✓ For those projects that were sufficiently developed in 2009, 76% of project leaders reported that it was easy or reasonably easy to obtain sufficient funds for operations and maintenance.
- ✓ Although the majority (62%) of project leaders indicated that it was “reasonable” to attract/retain technical personnel, almost one-quarter (21%) reported it was “very difficult” or “difficult.”

**Utilization of infrastructure**

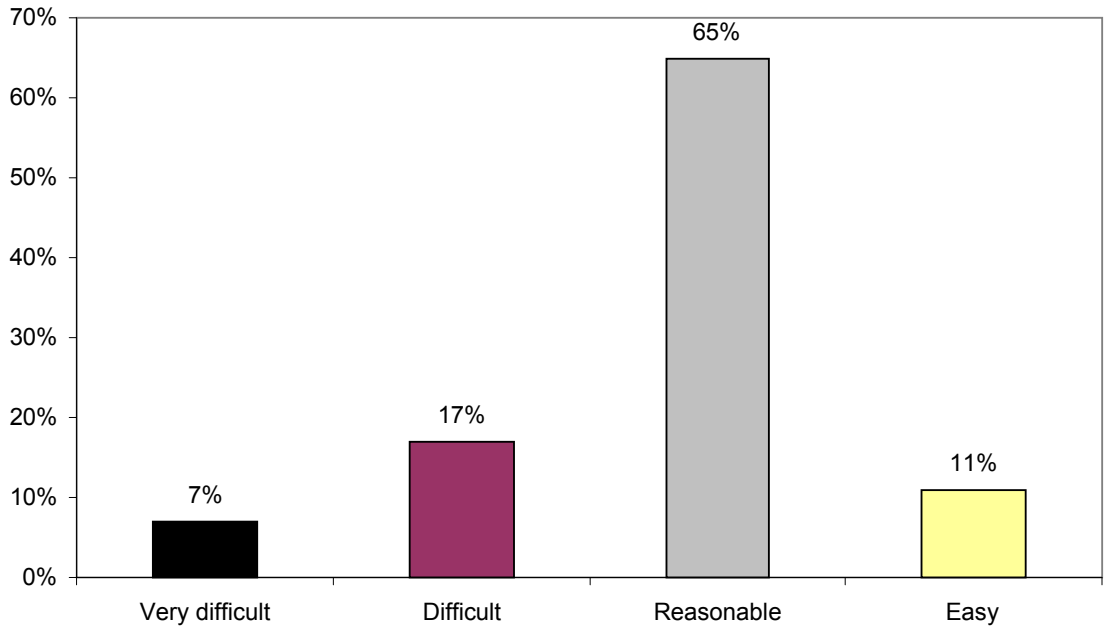
Table 15 shows that 75% of project leaders reported that the infrastructure was fully utilized. An additional nine percent of project leaders reported that the infrastructure was over subscribed. This pattern is relatively similar across funds.

| Table 15. Utilization of the infrastructure, by CFI fund | | |
|---|---|---|
| **Fund** | **Fully utilized** | **Over-subscribed** |
| Leaders Opportunity Fund (n=1,037) | 649 (63%) | 60 (6%) |
| New Opportunities Fund (n=833) | 607 (73%) | 66 (8%) |
| Canada Research Chairs (n=611) | 464 (76%) | 71 (12%) |
| Innovation Fund (n=121) | 69 (57%) | 13 (11%) |
| Leading Edge Fund (n=29) | 15 (52%) | 5 (17%) |
| New Initiatives Fund (n=30) | 14 (47%) | 1 (3%) |
| CFI Career awards (n=17) | 10 (59%) | 3 (18%) |
| Research Hospital Fund (n=9) | 6 (67%) | -- |
| International Access Fund (n=3) | 2 (67%) | -- |
| Exceptional Opportunities (n=2) | 2 (100%) | -- |
| National Platforms Fund (n=1) | 1 (100%) | -- |
| All Funds (n=2,452) | 1,839 (75%) | 219 (9%) |

### Funding for operations and maintenance

For those projects that were sufficiently developed in 2009, 76% of project leaders reported that it was easy or reasonably easy to obtain sufficient funds for operations and maintenance, while 24% reported that it was difficult or very difficult to obtain funds (Figure 7).

**Figure 7. Funding for operations and maintenance (n=2,452)**




**Attracting and retaining skilled personnel for operations and maintenance**

Table 16 summarizes the level of difficultly experienced by project leaders in attracting and retaining technical personnel for operations and maintenance of CFI-funded infrastructure. Although the majority (62%) of project leaders indicated that it was “reasonable” 21% reported it was “very difficult” or “difficult” to attract and/or retain technical personnel.

**Table 16. Ease of attracting and retaining skilled personnel for operations and maintenance**

| | No. of projects |
|---|---|
| Easy | 446 (18%) |
| Reasonable | 1,511 (62%) |
| Difficult | 333 (14%) |
| Very difficult | 162 (7%) |
| Total | 2,452 (100%) |

**Difficulties attracting and retaining technical personnel for the operation and maintenance of CFI-funded infrastructure (n=350)**

Almost 500 project leaders elaborated on the difficulties of attracting and retaining technical personnel for the operation and maintenance of the CFI-funded infrastructure.[11] The following analysis is based on the examination of 350 project leader comments.

Less than one-fifth of the project leaders reported difficulties in this area, but the qualitative information offers valuable feedback on their challenges. The comments received demonstrate both the challenges faced by some projects leaders in keeping their projects operational with insufficient or episodic operating funds, and a testimony to the dedication and commitment of project leaders and the research staff to keep their projects operational.

> *In the past year, our technicians have spent unreasonable time at sea under the exacting work conditions of the High Arctic ... The pressure on the personal life and family of the technicians is enormous... Recruiting qualified technicians has been difficult because of the low offer on the market, and these defections considerably increased the strain on the team.* **Université Laval**

Project leaders report how difficult it can be to conduct some research projects without funding for the operation and maintenance of state-of-the-art equipment. The overarching problem, therefore, is the lack of stable and sufficient operations and maintenance funding, which is compounded by several factors, grouped under five broad themes.

### 1. Shortage of trained technical staff in some research areas

Project leaders noted that the equipment involved in some projects was highly specialized and only a small pool of qualified individuals was able to work as research technicians.

### 2. Competitive fields of expertise

Project leaders reported that the rapid growth of some research areas worldwide makes recruitment and retention a challenge. This is especially true in research areas that have caught the interest of the private sector.

**"The departure of one IT analyst has left a vacant position not yet filled due to how competitive recruitment in this sector is in the private sector. One technician has ensured that part of the analyst work gets done."** **Université du Québec**

### 3. Turnover of staff

Project leaders noted the elevated level of technical skill required to work within highly specialized research projects where qualified individuals are not abundant. Given the nature of granting cycles, technical operation and maintenance staff are often hired under contract, with only finite employment guarantees. This makes it difficult to keep them on the job for the length of a project and/or for long periods of time.

**"There has been a fairly large turnover of technicians in my lab. In most cases, I have only been successful at retaining personnel through a one-year contract."** **University of Western Ontario**

### 4. Isolation of research centres

[11] PPR 2009, Question 13: "In the past year, how easy or difficult has it been to attract and retain skilled personnel (e.g. technicians) for operations and maintenance of the infrastructure?"

Recruiting highly qualified staff to isolated research sites compounds the problem of insufficient and episodic funding. A lack of local skilled personnel is a serious problem for such projects. To attract candidates, researchers must offer attractive salaries or find personnel who fit the particular location and work demands.

### 5. Economic recession: Hiring freezes and budget cuts

Some project leaders reported that their institutions have implemented budget cuts resulting in complete or conditional hiring freezes. Additionally, some project leaders have also endured the loss of endowment income or capital due to the current economic recession.

### 6. Training students

Several project leaders noted that a lack of necessary funding has led them to train students (undergraduates and graduates) how to operate their CFI-funded equipment. Although this makes the operation and maintenance problem manageable, few project leaders believed it was an optimal solution. Other project leaders noted that students could not operate their equipment since it is highly specialized and demands a specialized training.

**"Stable and sufficient funding for technicians is not available. The infrastructure was designed so that graduate students could operate and maintain [the equipment] after sufficient training. Though not ideal, this does provide an important component in their overall professional training"**
**University of Western Ontario**